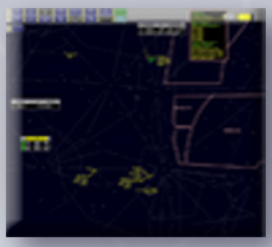
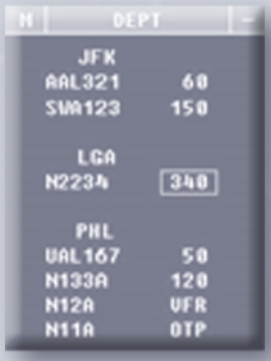
FAA Lesson Plan



En Route Stage 4
Radar Controller Training



Student

Fundamentals of ATC Surveillance Systems
Lesson 1

55055
V.1.06

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LESSON PLAN DATA SHEET

COURSE NAME:	RADAR CONTROLLER TRAINING
COURSE NUMBER:	55055
LESSON TITLE:	FUNDAMENTALS OF ATC SURVEILLANCE SYSTEMS
DATE REVISED:	2014-04
VERSION:	1.06
REFERENCES:	JO 7110.65V, Air Traffic Control; JO 7110.10X, Flight Services; JO 7210.3Y, Facility Operation and Administration; JO 7610.4S, Special Operations; Aeronautical Information Manual (AIM); ETM 12-0-1, Fundamentals of Primary and Secondary Surveillance Radar; TI 6110.100, En Route Automation Modernization (ERAM) Air Traffic Manual (ATM): R-Position User Manual; AC 90-114, Automatic Dependent Surveillance Broadcast (ADS-B) Operations; 14 CFR 91.225, Automatic Dependent Surveillance-Broadcast (ADS-B) Out equipment and use; ERAM SURV SRS 210.24, En Route Automation Modernization (ERAM) Surveillance (SURV); ERAM DS DD 240.07, En Route Automation Modernization (ERAM) Display System (DS) Data Dictionary (DD); TI 6110.141, En Route Automation Modernization (ERAM) System Adaptation Manual (SAM): Local Data Panels; JO 7110.66D CHG 2, National Beacon Code Allocation Plan (NBCAP); ERAM EDSM SRS 210.04 V1B1, En Route Automation Modernization (ERAM) En Route Display Management (EDSM) R-Position and General EDSM Requirements Volume 1, Book 1
HANDOUTS:	NONE
EXERCISES:	NONE
END-OF-LESSON TEST:	YES
PERFORMANCE TEST:	NONE
MATERIALS:	NONE
OTHER PERTINENT INFORMATION:	THIS LESSON IS BASED ON ERAM BUILD EAC1500. THE LESSON HAS BEEN REVIEWED AND REFLECTS CURRENT ORDERS AND MANUALS AS OF APRIL 2014.

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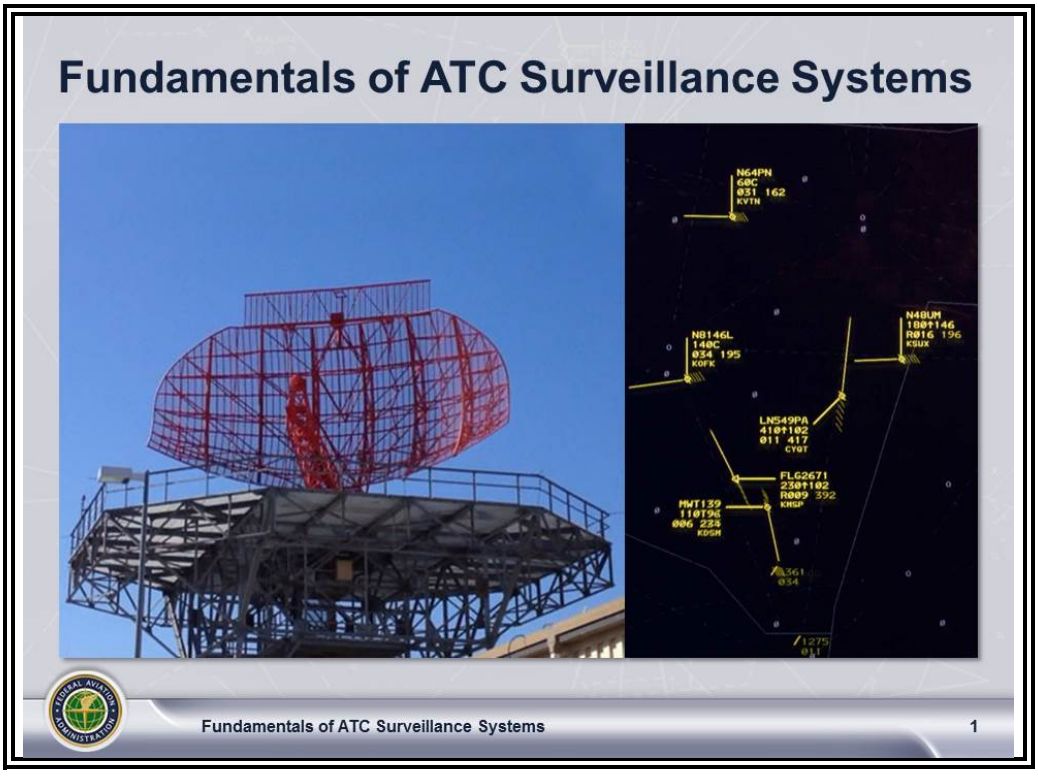
INTRODUCTION



In previous stages of instruction, you learned about manual air traffic control. This stage of training focuses on various ATC Surveillance Systems, which are some of the controller's most valuable aids.

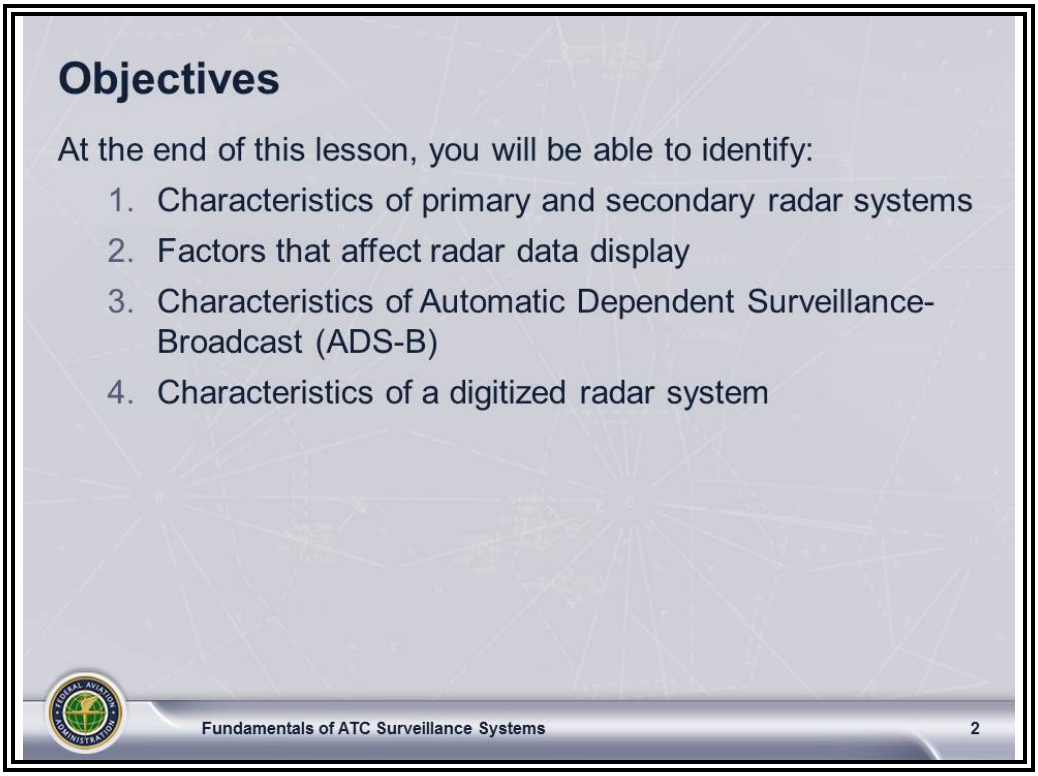
Purpose

A basic knowledge of ATC Surveillance Systems and the components associated with a digitized radar system will benefit you in Radar On-the-Job Training (OJT). This knowledge will assist you in attaining Certified Professional Controller (CPC) status.

In this lesson you will learn the fundamentals of ATC Surveillance Systems.

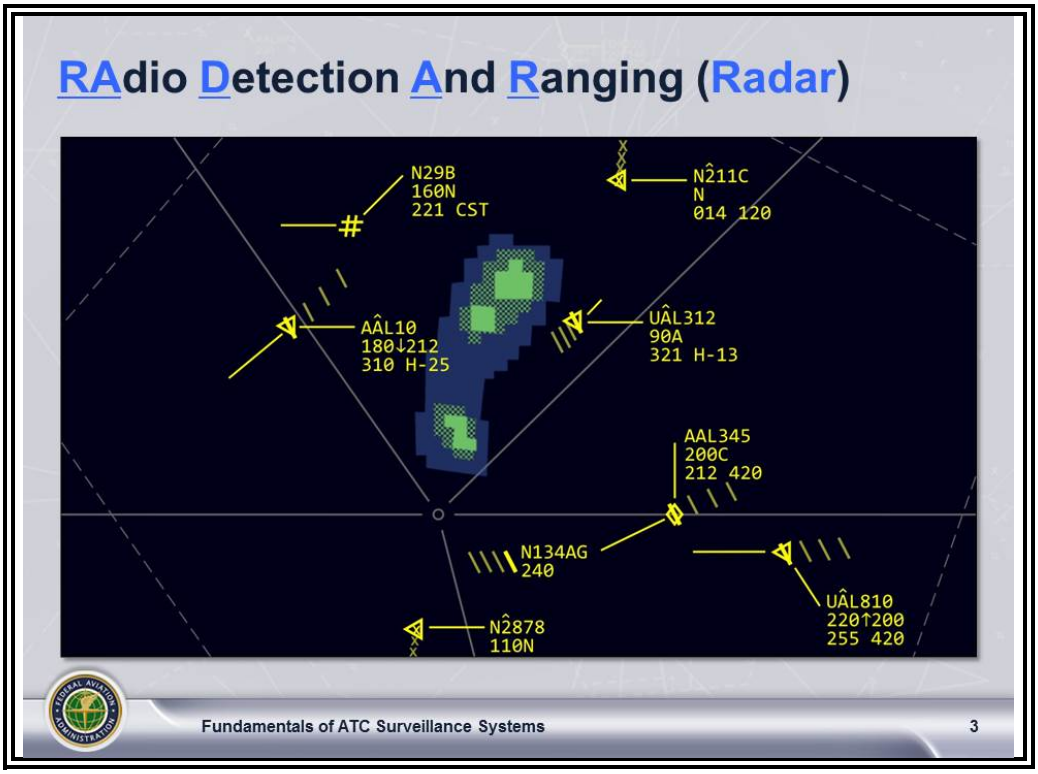
INTRODUCTION *(Continued)*

Objectives



PRIMARY RADAR SYSTEM

Radar Definition
ETM 12-0-1, pp. 5, 6, Glossary; JO 7110.65, Pilot/Controller Glossary



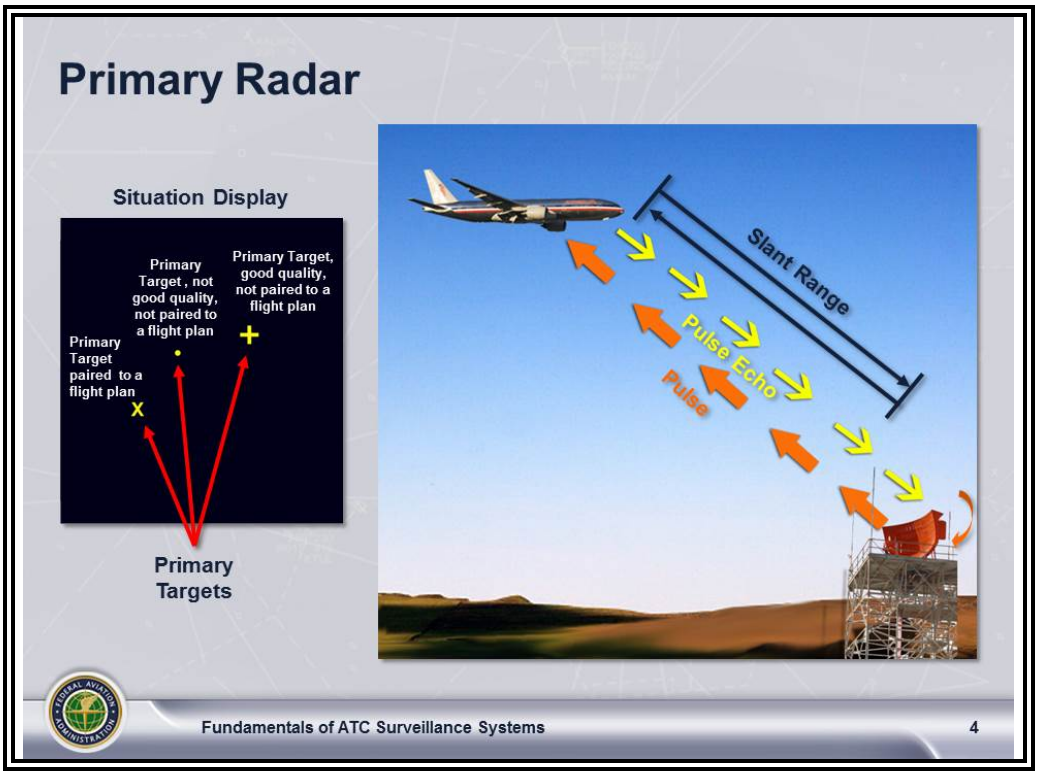
Radar (**RA**dio **D**etection **A**nd **R**anging) is a radio detection device that provides information on range, azimuth, and/or elevation of objects.

PRIMARY RADAR SYSTEM *(Continued)*

Primary Radar Definition
ETM 12-0-1, Glossary;
JO 7110.65, Pilot/Controller Glossary

Primary Radar is a radar system which uses reflected radio signals.

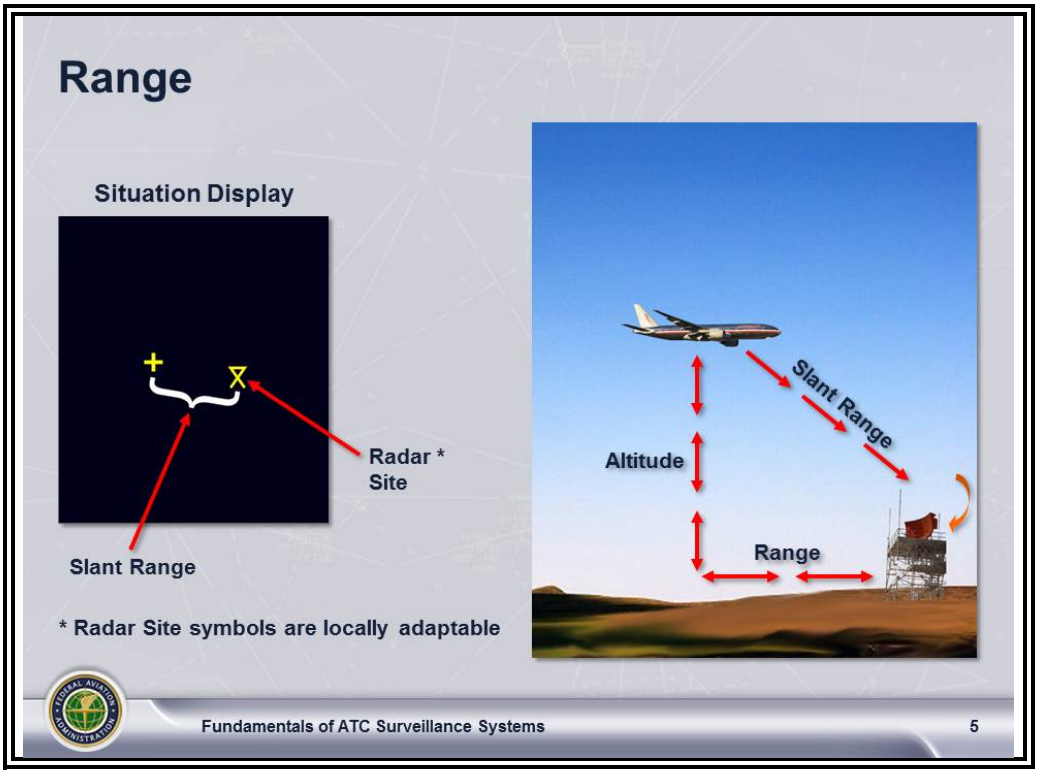
Process
ETM 12-0-1, pp. 5, 6, Glossary;
JO 7110.65, Pilot/Controller Glossary; ERAM EDSM SRS 210.04 V1B1, par. 3.2.2.1



- Antenna transmits
- Aircraft/object reflects
- Antenna receives
- Computer processes
- Center indicator displays position in terms of range and azimuth

PRIMARY RADAR SYSTEM *(Continued)*

Range and Azimuth Definitions
ETM 12-0-1,
pp. 7, 8, Glossary



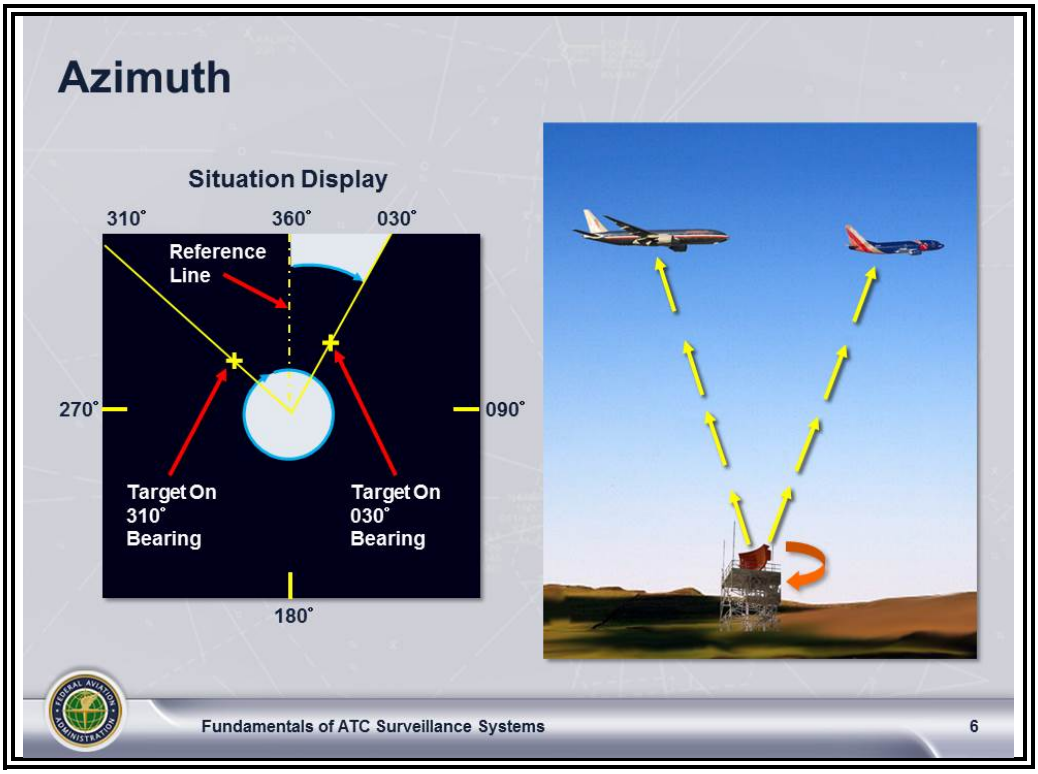
📖 **Range** is the distance from the antenna to a point on the ground directly below the aircraft.

📖 **Slant range** is the distance from antenna to aircraft.

Continued on next page

PRIMARY RADAR SYSTEM *(Continued)*

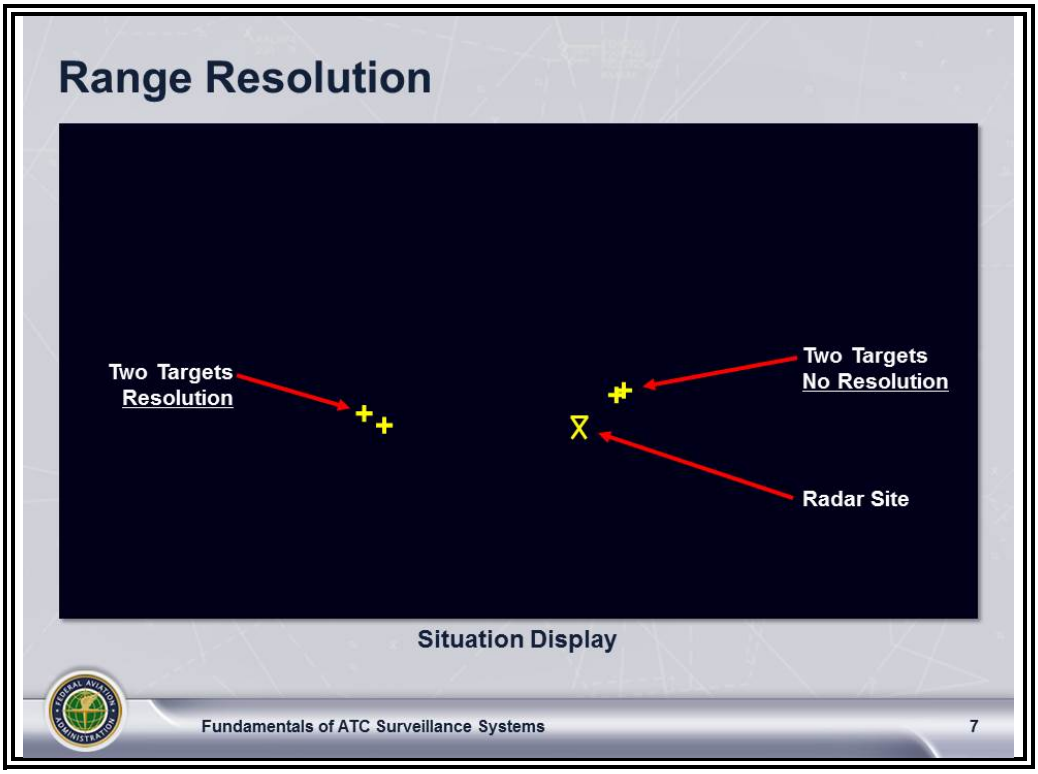
Range and Azimuth Definitions (Cont'd)
ETM 12-0-1, pp. 7, 8, Glossary



Azimuth is the direction from the antenna based on a 360° circle measured clockwise from a reference line.

PRIMARY RADAR SYSTEM *(Continued)*

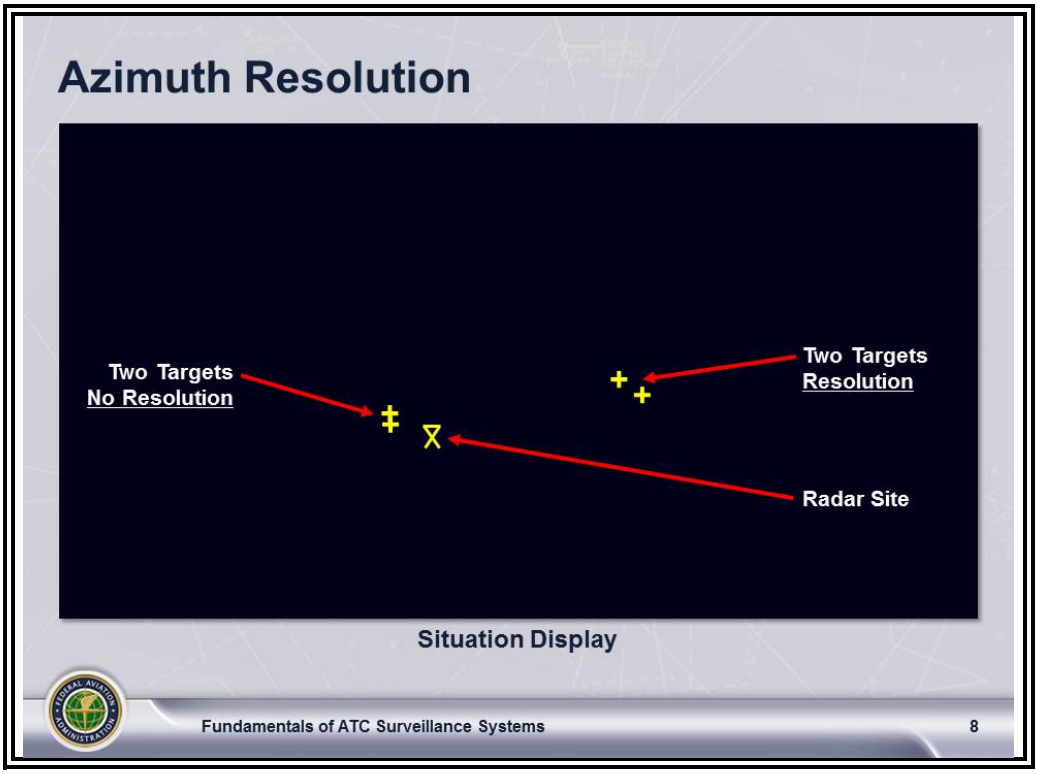
Range Resolution Definition
ETM 12-0-1,
pp. 7, 8, Glossary



Range resolution is the minimum distance between two returns, measured along the same azimuth, at which returns still appear as separate, distinct targets.

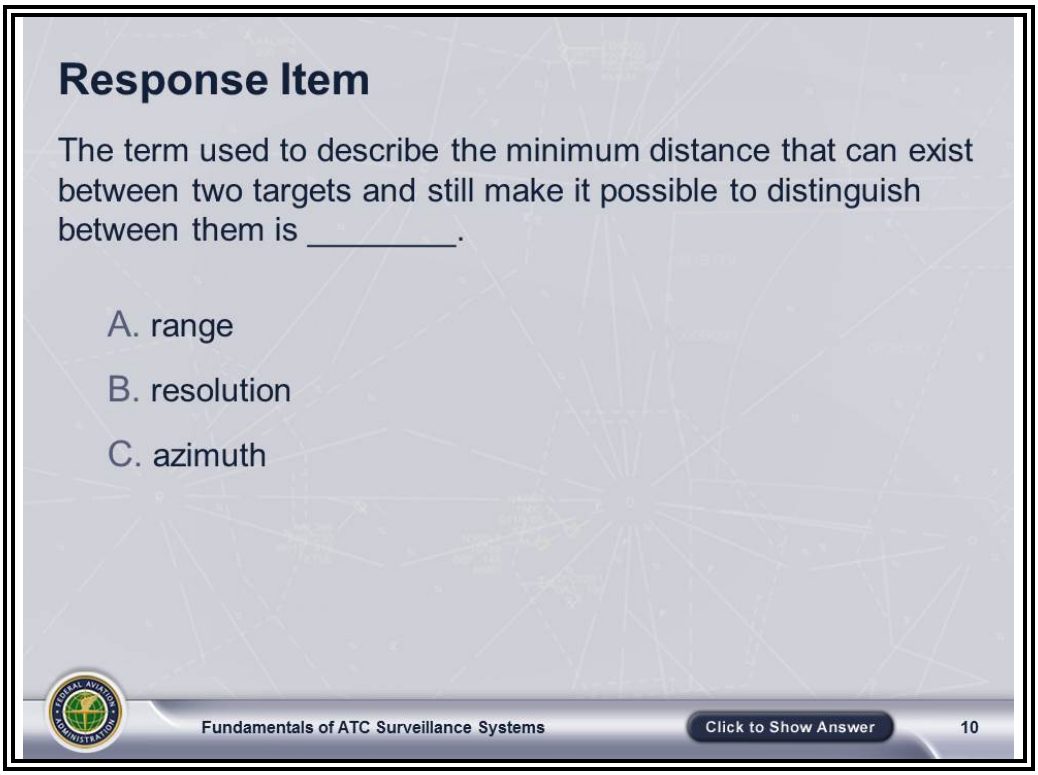
PRIMARY RADAR SYSTEM *(Continued)*

Azimuth Resolution Definition
ETM 12-0-1, p. 8



Azimuth resolution is the minimum angular distance between two returns, measured at the same range, at which returns still appear as separate, distinct targets.

Review



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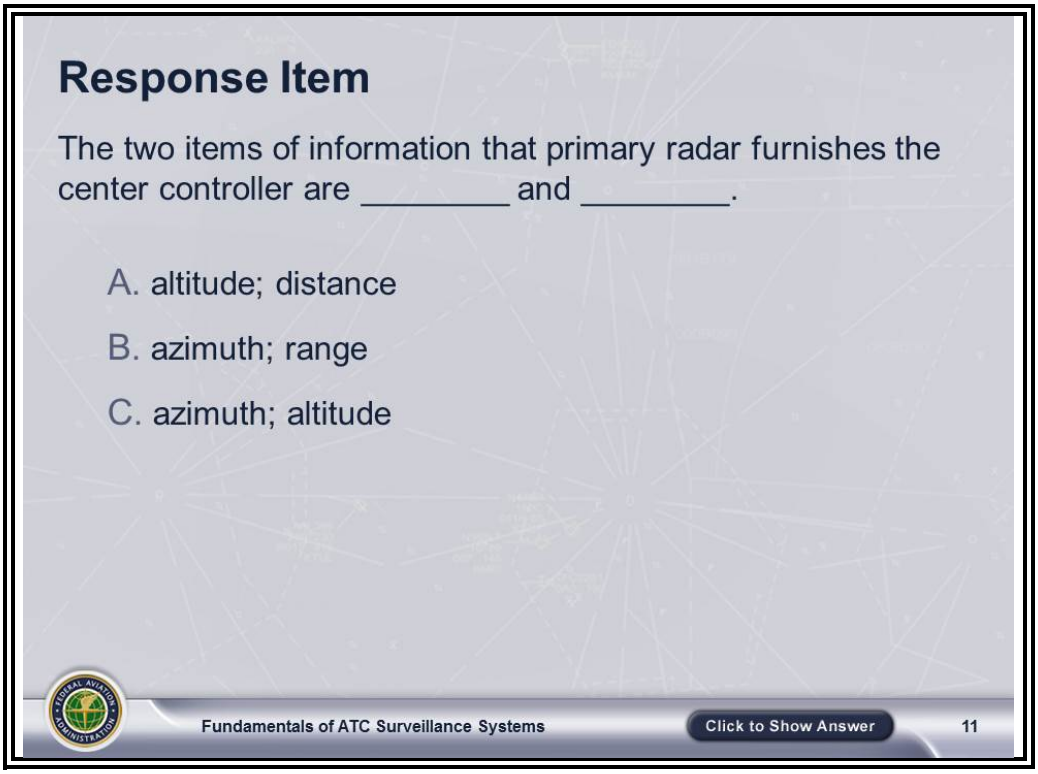
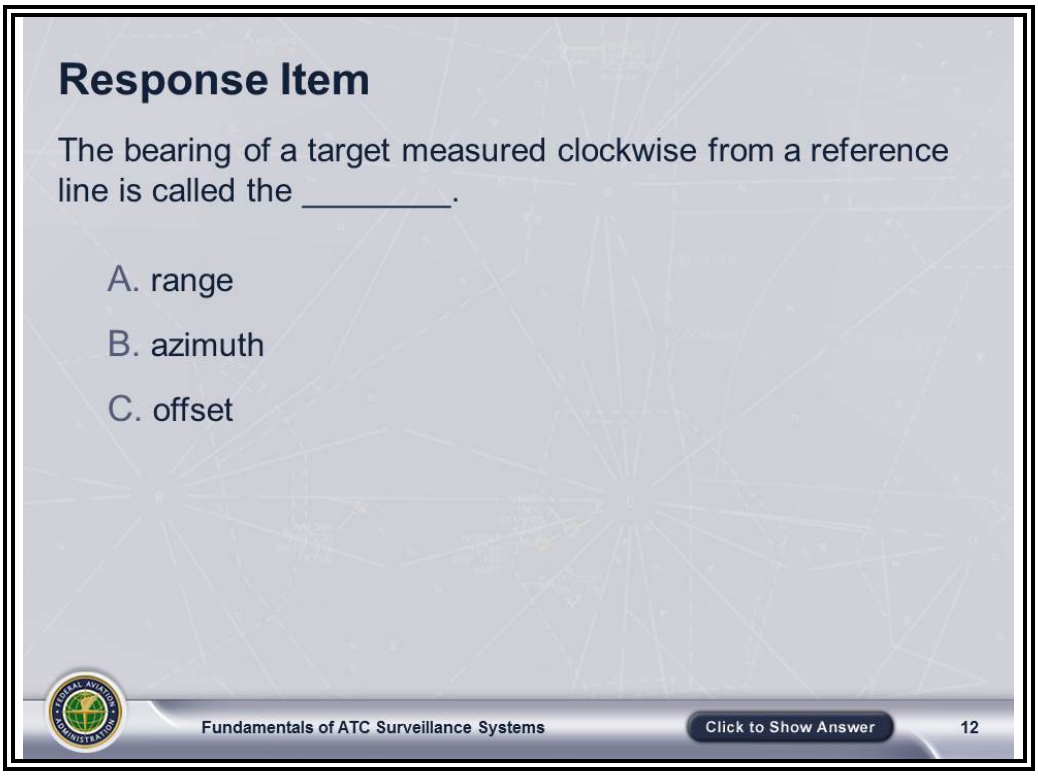
PRIMARY RADAR SYSTEM *(Continued)*

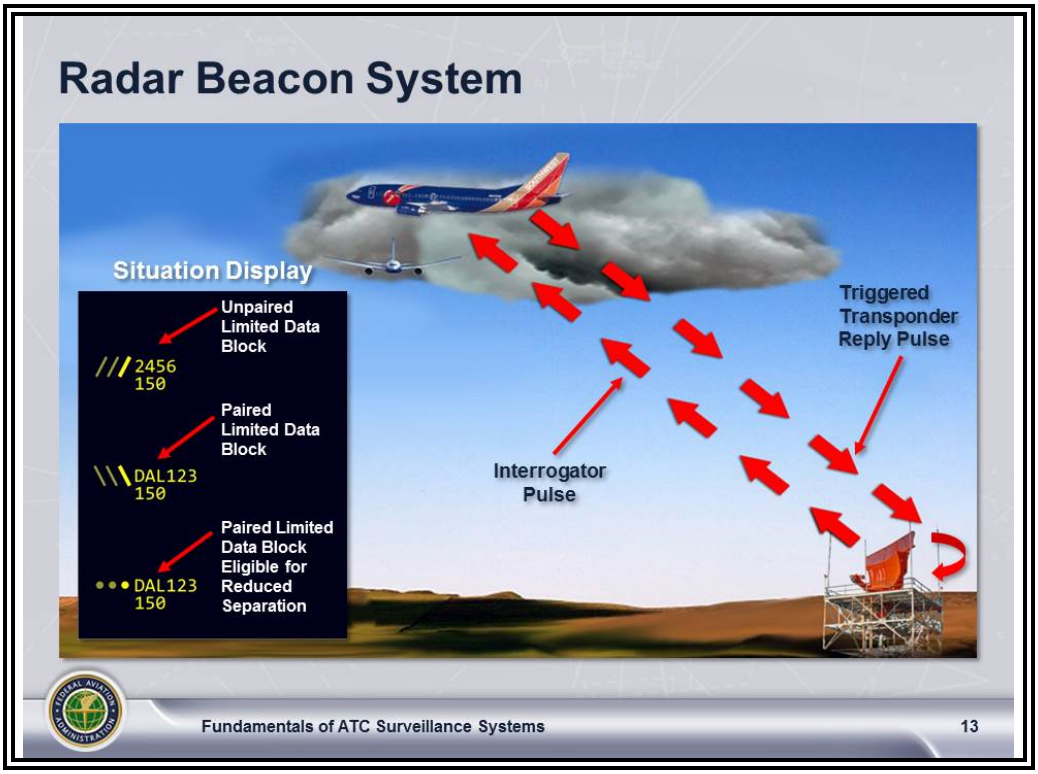
Review (Cont'd)





AIR TRAFFIC CONTROL RADAR BEACON SYSTEM (ATCRBS) - SECONDARY RADAR

Overview
ETM 12-0-1, p. 35, Glossary; JO 7110.65, Pilot/Controller Glossary; AIM, par. 4-5-2



Secondary Radar Definition
JO 7110.65, Pilot/Controller Glossary; AIM, par. 4-5-2

Secondary Radar is a radar system wherein a radio signal transmitted from a radar station initiates the transmission of a radio signal from another station.

- Secondary radar relies on a specific radio transmission from an aircraft.
- The detected object has cooperative equipment in form of radio/transmitter (transponder).
- The secondary return reinforces or replaces the primary return.
- Primary and secondary radar antennas are collocated.

AIR TRAFFIC CONTROL RADAR BEACON SYSTEM (ATCRBS) - SECONDARY RADAR *(Continued)*

Process
AIM, par. 4-5-2;
ERAM EDSM SRS 210.04 V1B1, par. 3.2.2.1

- ⊙ Interrogator generates and transmits signal through antenna
- ⊙ Transponder replies
- ⊙ Interrogator receives transponder reply through antenna
- ⊙ Computer processes information
- ⊙ Situation Display displays beacon target

Radar Beacon Modes
ETM 12-0-1, pp. 41, 52

- ⊙ Modes are different pulses on which the interrogator transmits and receives data.
  - Mode 1 (military use)
  - Mode 2 (military use)
  - Mode 3/A (military and civil use)
  - Mode C (military and civil use)
  - Mode S (military and civil use)
- ⊙ ATC utilizes only:
  - Mode 3/A for target tracking and identification.
  - Mode C for altitude reporting.
  - Mode S
    - Altitude readout in digitized radar system

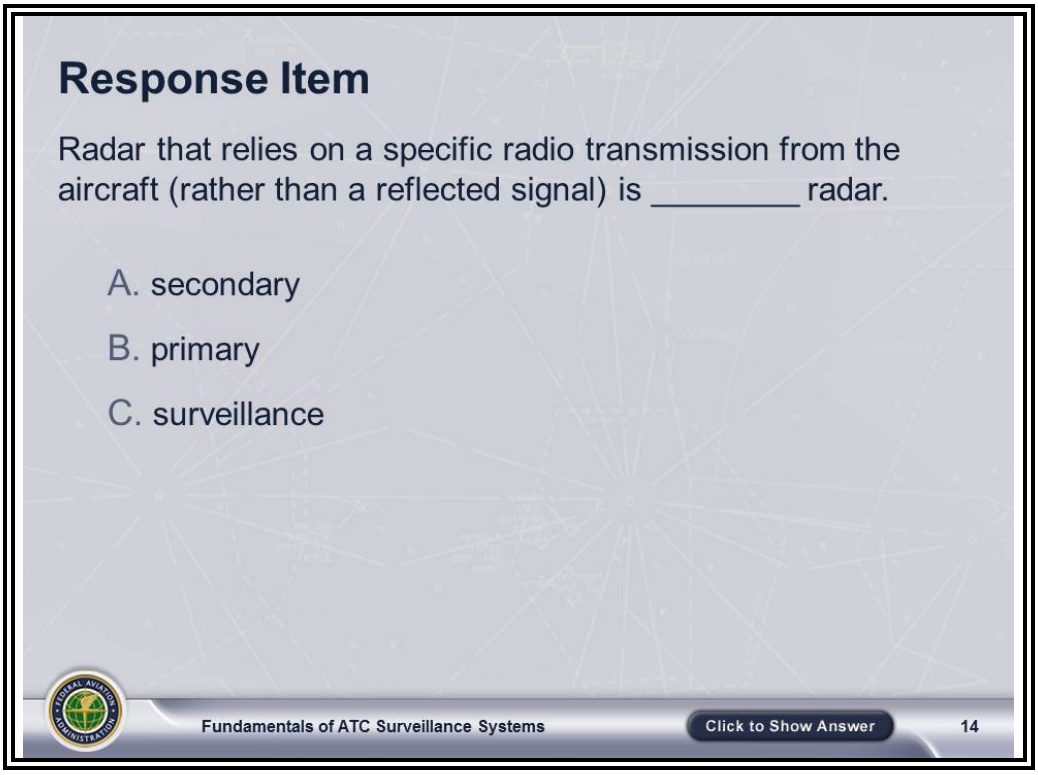
Radar Beacon Codes
JO 7110.66, par. 11

- ⊙ The transponder transmits numerical signals from an octal number group from 0 to 7.
  - The numbers 8 and 9 cannot be used.

NOTE: Code 7777 is the largest numerical value.

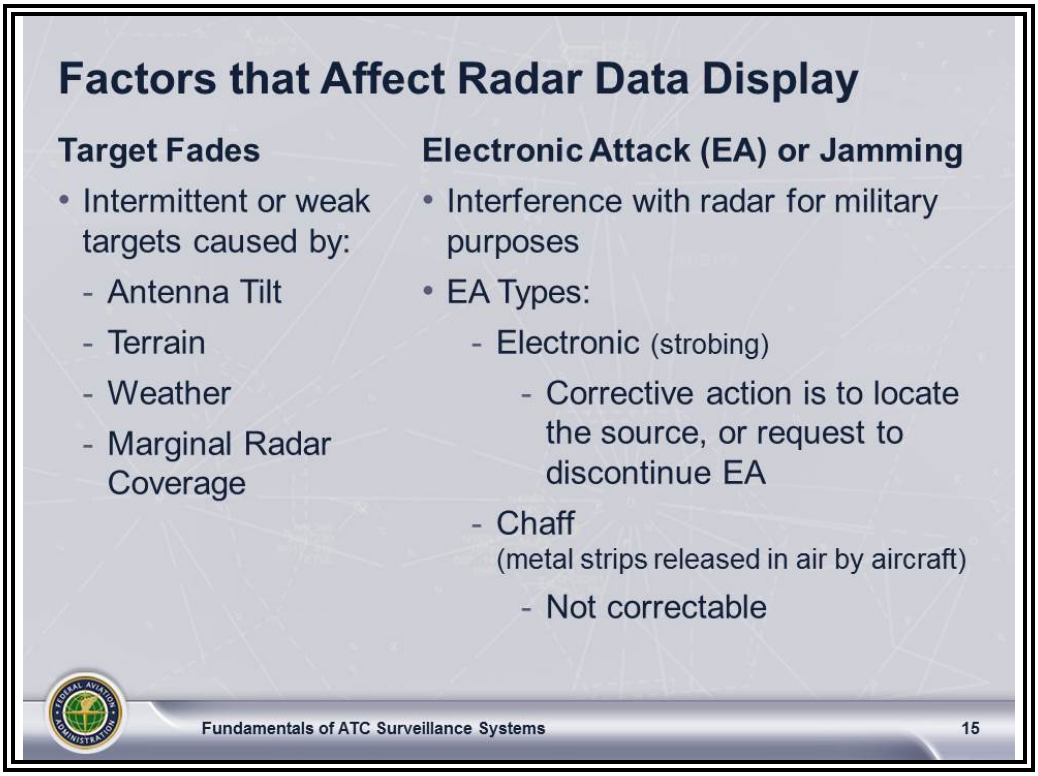
AIR TRAFFIC CONTROL RADAR BEACON SYSTEM (ATCRBS) - SECONDARY RADAR *(Continued)*

Review



FACTORS THAT AFFECT RADAR DATA DISPLAY

Target Fades
ETM 12-0-1,
pp. 29 thru 34,
Glossary



⊙ Target fades are intermittent or weak targets caused by:

- Antenna tilt
- Terrain
- Weather
- Marginal radar coverage

Continued on next page

FACTORS THAT AFFECT RADAR DATA DISPLAY
(Continued)

Electronic Attack (EA) or Jamming (Cont'd)
JO 7110.65, par. 5-1-5; JO 7610.4, par. 2.7

- Electronic Attack (EA) or jamming is interference with radar for military purposes.
- Refer all EA requests to the appropriate FLM/CIC.
- Types
  - Electronic (Strobing)
  - Chaff - Thin metal strips released in air by aircraft
- Corrective action
  - Strobing
    - Locate source
    - Request to discontinue EA (Inform when able to resume)
  - Chaff
    - Not correctable
    - Moves with wind until dissipated

✈ **Phraseology**

"BIG PHOTO (identification, if known) (name) CENTER/TOWER/APPROACH CONTROL."

- To stop EA activity:

✈ **Phraseology**

"STOP STREAM/BURST IN AREA (area name) (degree and distance from facility)."

or

"STOP BUZZER ON (frequency band or channel)."

- To resume EA activity:

✈ **Phraseology**

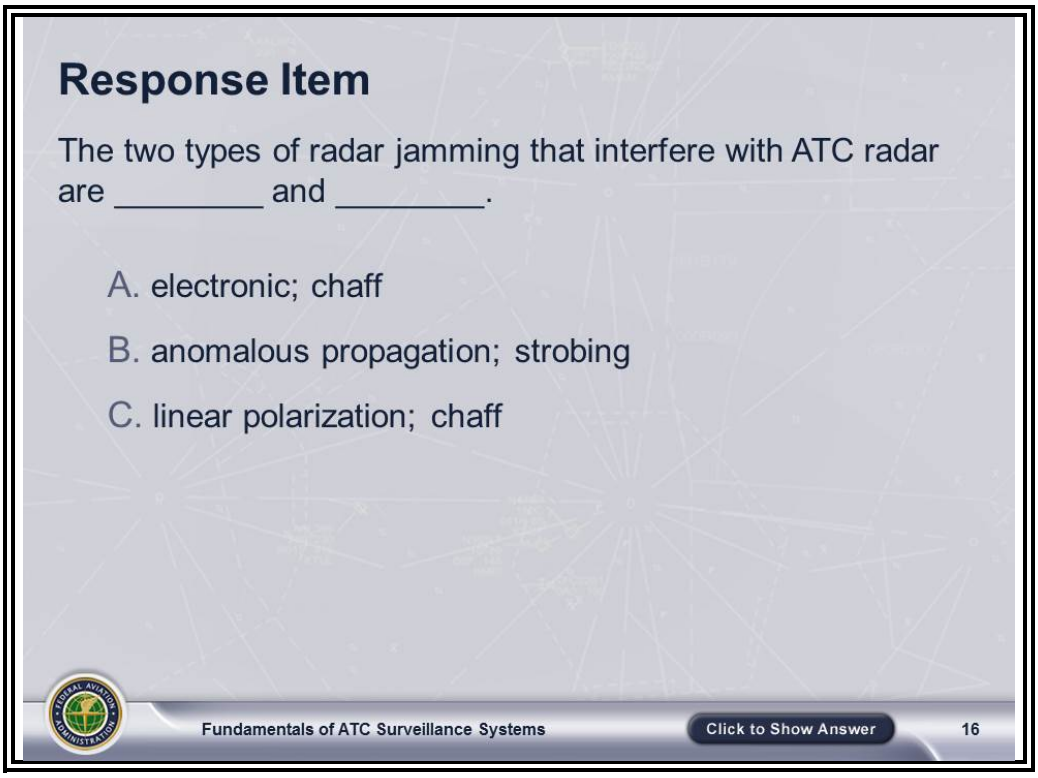
"RESUME STREAM/BURST."

or

"RESUME BUZZER ON (frequency band or channel)."

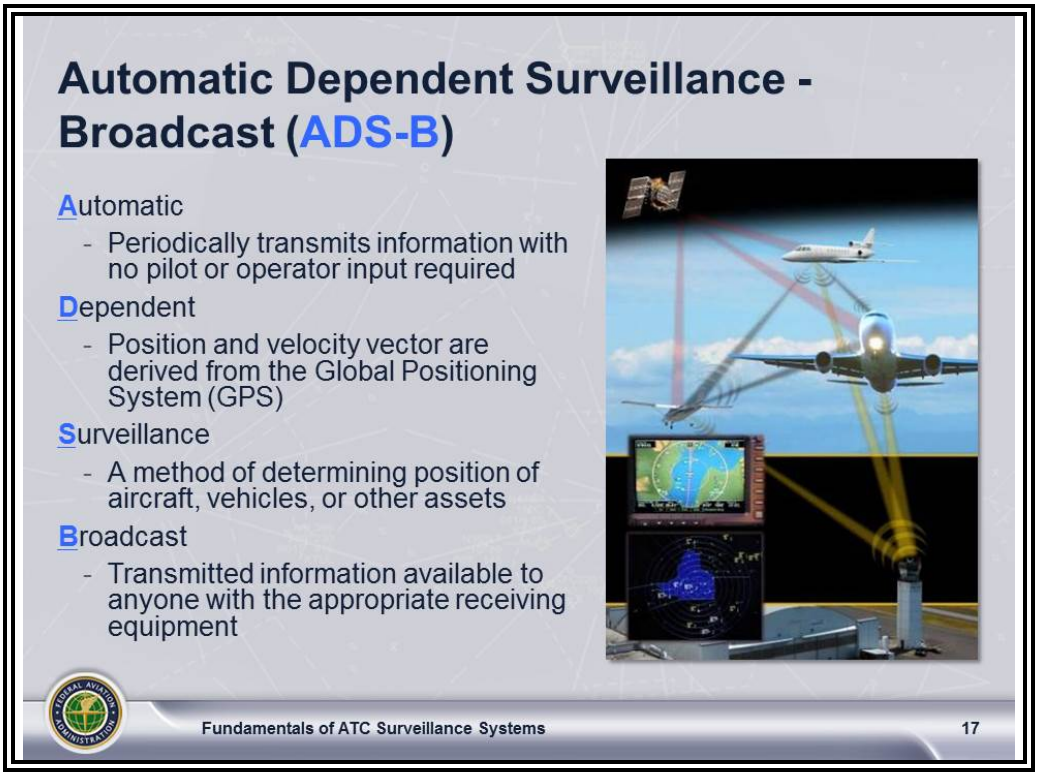
FACTORS THAT AFFECT RADAR DATA DISPLAY
(Continued)

Review



ADS-B

Overview
14 CFR 91.225



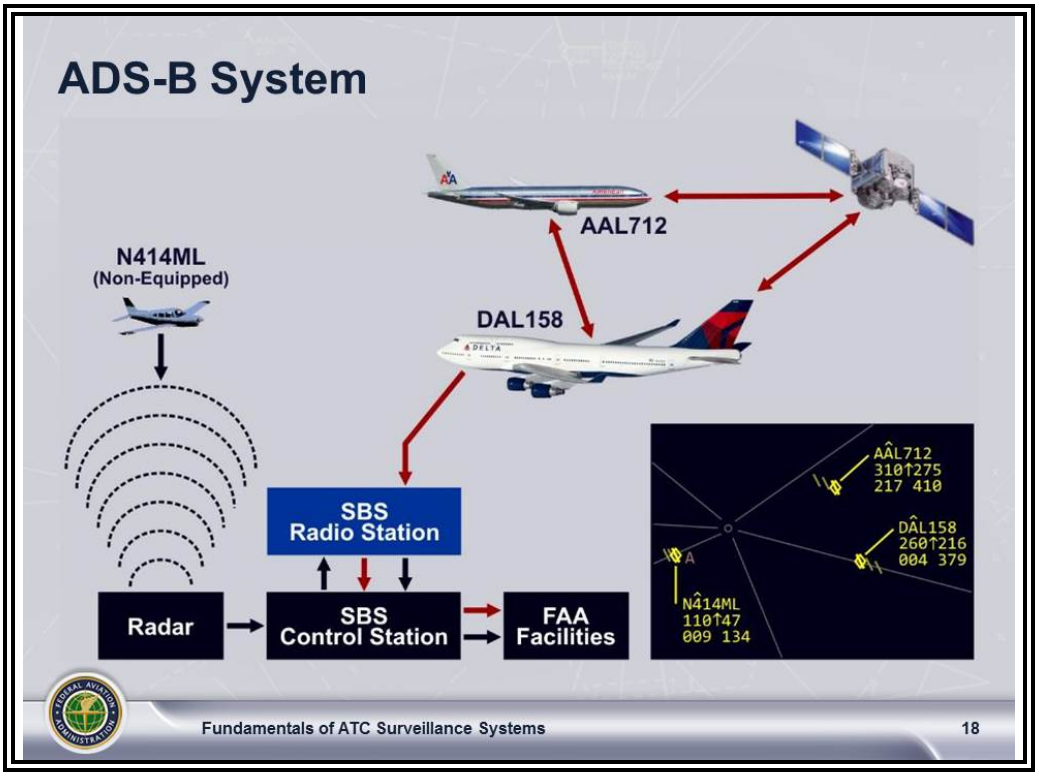
ADS-B Definition
JO 7110.65, Pilot/Controller Glossary;
14 CFR 91.225

Automatic Dependent Surveillance-Broadcast (ADS-B) is a surveillance technology for tracking aircraft as part of the Next Generation Air Transportation System (NextGen). The United States will require the majority of aircraft operating within its airspace to be equipped with some form of ADS-B Out by January 1, 2020.

- The difference between ADS-B and traditional radar sources is the broadcast feature.
  - Position determination is made on the aircraft, not by radar.
  - Aircraft position is broadcast to other aircraft and back to ATC ground-based radio receivers.
- ADS-B enhances safety by making aircraft visible, in real time, to ATC and to other ADS-B aircraft with position and velocity data.
- ADS-B also provides the data infrastructure for inexpensive flight tracking, planning, and dispatch.

ADS-B *(Continued)*

Process
AC 90-114,
par. 2-2.a



- The ADS-B system is composed of aircraft avionics and a ground infrastructure.
- On-board avionics use GPS satellite signals to determine aircraft position.
- ADS-B transceiver broadcasts a position (latitude/longitude) report, along with other information, such as:
  - Pressure altitude (like Mode C)
  - Beacon code
  - Call sign
  - ICAO aircraft address
- Transmissions are received by:
  - Other ADS-B aircraft, giving them greater situational awareness
  - Network of ground radio stations contracted to FAA
  - Other aviation service providers

Continued on next page

ADS-B *(Continued)*

Process (Cont'd)
AC 90-114, par. 2-2.a

- The radio stations stream the reports over a wide area network to control stations that process the information and forward reports to ATC facilities.

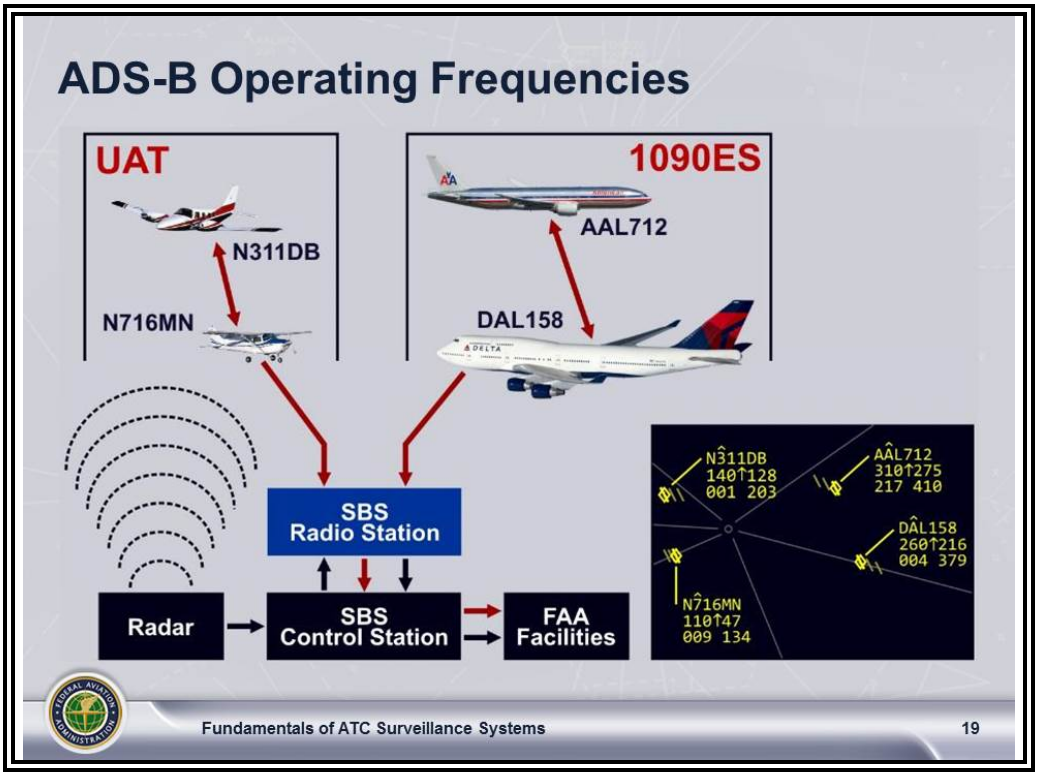
NOTE: The ground system of radio stations, data centers, and wide area network is known collectively as Surveillance and Broadcast Services (SBS).

- For controllers, the result is an accurate display of ADS-B flights showing precise locations.

- ADS-B data can be recorded and downloaded for post-flight analysis.

ADS-B *(Continued)*

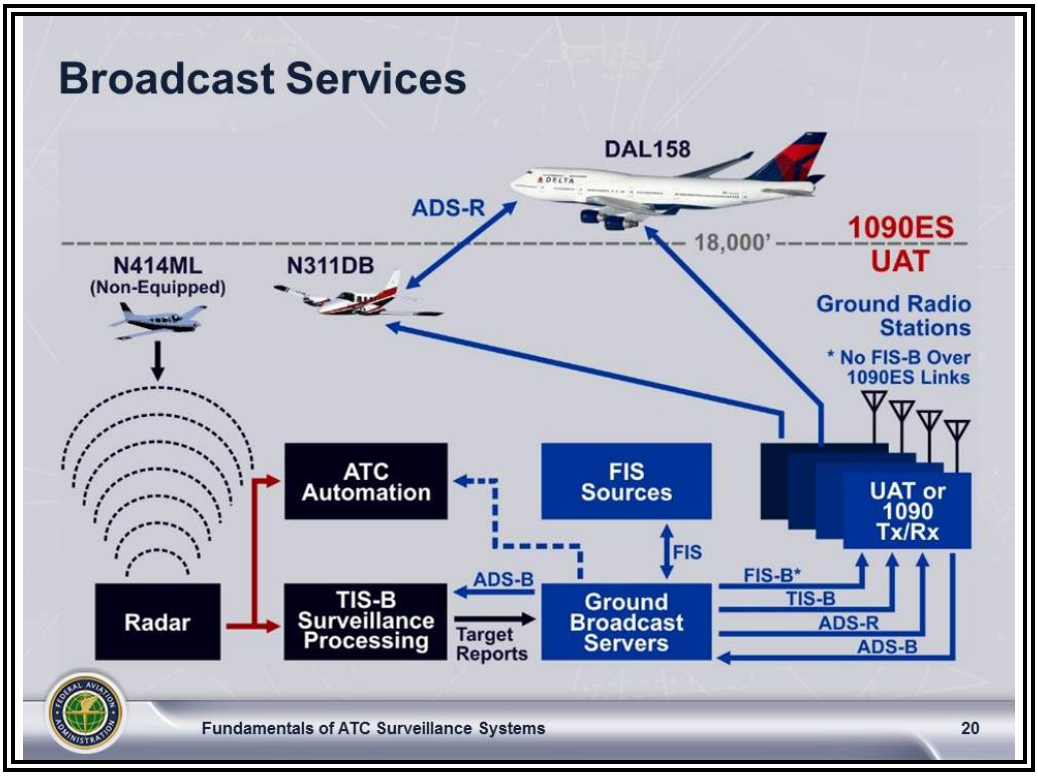
Operating Frequencies and Modes
AC 90-114, par. 2-2.b



- ADS-B operates on two frequencies:
  - Universal Access Transceivers (UAT)
    - 978 MHz
    - Used by general aviation
    - Used below 18,000
  - 1090ES (1090 MHz)
    - 1090 MHz
    - Used by most commercial aircraft and by military aircraft
    - Required at or above FL180 (Class A), but usable at all altitudes
- ADS-B avionics can have the ability to transmit and receive information.
  - ADS-B Out - transmission of ADS-B information
  - ADS-B In - receipt of ADS-B information

ADS-B *(Continued)*

Broadcast Services
AC 90-114, par. 2-3



⊙ SBS broadcasts information to aircraft as a service to aviation, which increases pilot situational awareness.

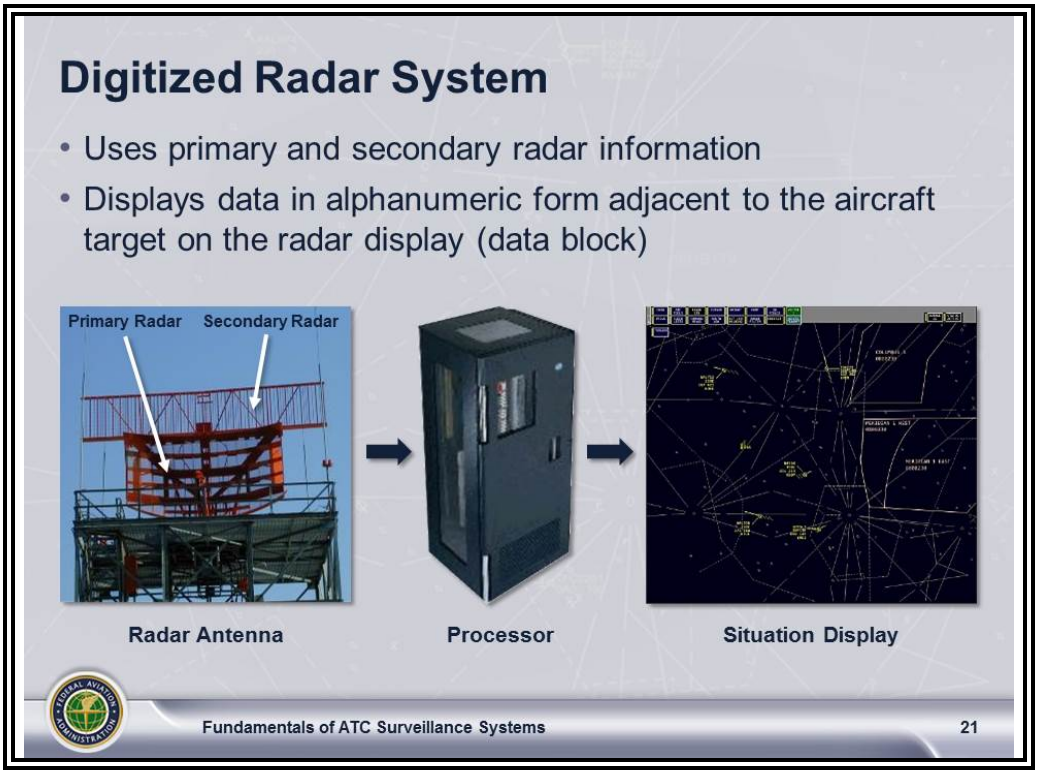
- Automatic Dependent Surveillance - Rebroadcast (ADS-R):
  - Because the ADS-B system operates on two separate frequencies, the information from each frequency must be reformatted and rebroadcast to enable aircraft operating on the alternate frequency to process and use the other's information.
  - This process occurs within the ADS-B control station.

NOTE: Aircraft operating on the same ADS-B frequency exchange information directly (don't require translation). Aircraft with ADS-B IN capability on both UAT and 1090ES do not require ADS-R services

- Traffic Information Services - Broadcast (TIS-B): Provides ADS-B-IN equipped aircraft with a more complete picture of surrounding traffic, including non- ADS-B aircraft.
- Flight Information Services - Broadcast (FIS-B): Provides weather and aeronautical information. Available only to UATs.

DIGITIZED RADAR SYSTEM

Digitized Radar System Definition
ETM 12-0-1, p. 53



A **Digitized Radar System** uses basic primary and secondary radar information and displays it in alphanumeric form adjacent to the aircraft target on the radar display.

DIGITIZED RADAR SYSTEM *(Continued)*

Characteristics
ETM 12-0-1, p. 53;
TI 6110.100,
par. 1.2.7

- Uses basic radar information in alphanumeric form
- Data are grouped in a data block, which conforms to a specified tabular form.

DIGITIZED RADAR SYSTEM *(Continued)*

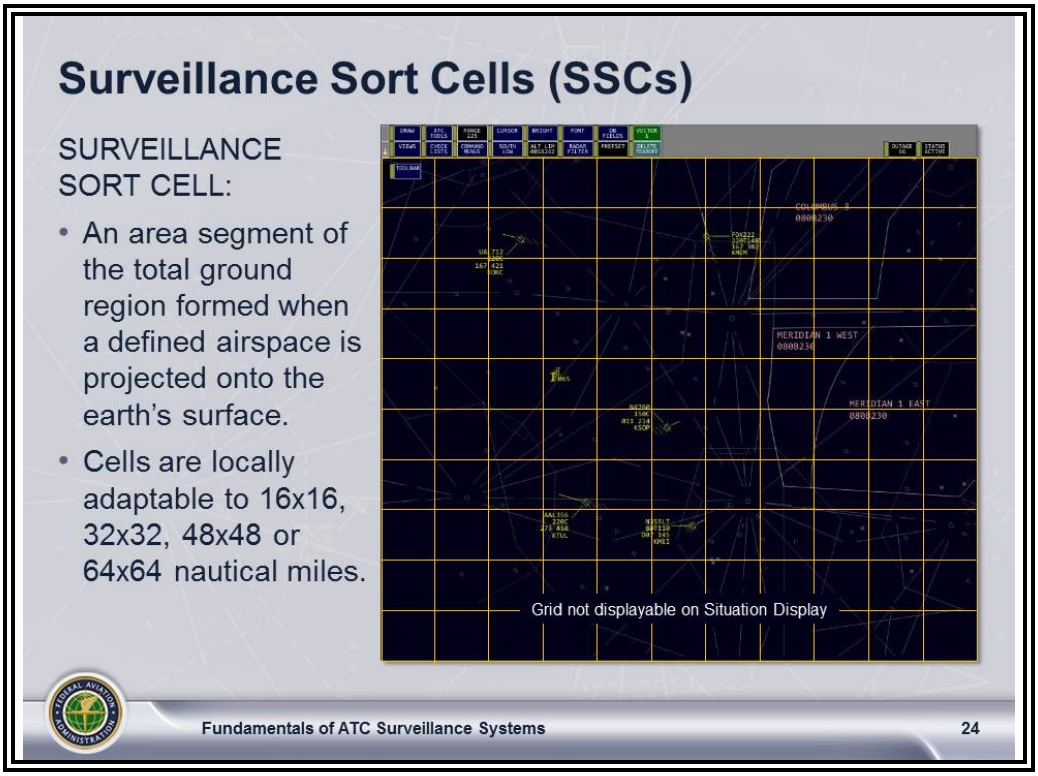
R-Position Console
TI 6110.100, LOA-18

NOTE: Digitized radar equipment will be covered in later lessons.

- System displays computer-processed alphanumeric data
  - Vertical face of the Flat Panel Monitor is known as a Situation Display

DIGITIZED RADAR SYSTEM *(Continued)*

Surveillance Sort Cells (SSCs)
TI 6110.141, 2-649 to 2-655



⊙ Grids divide the Situation Display.

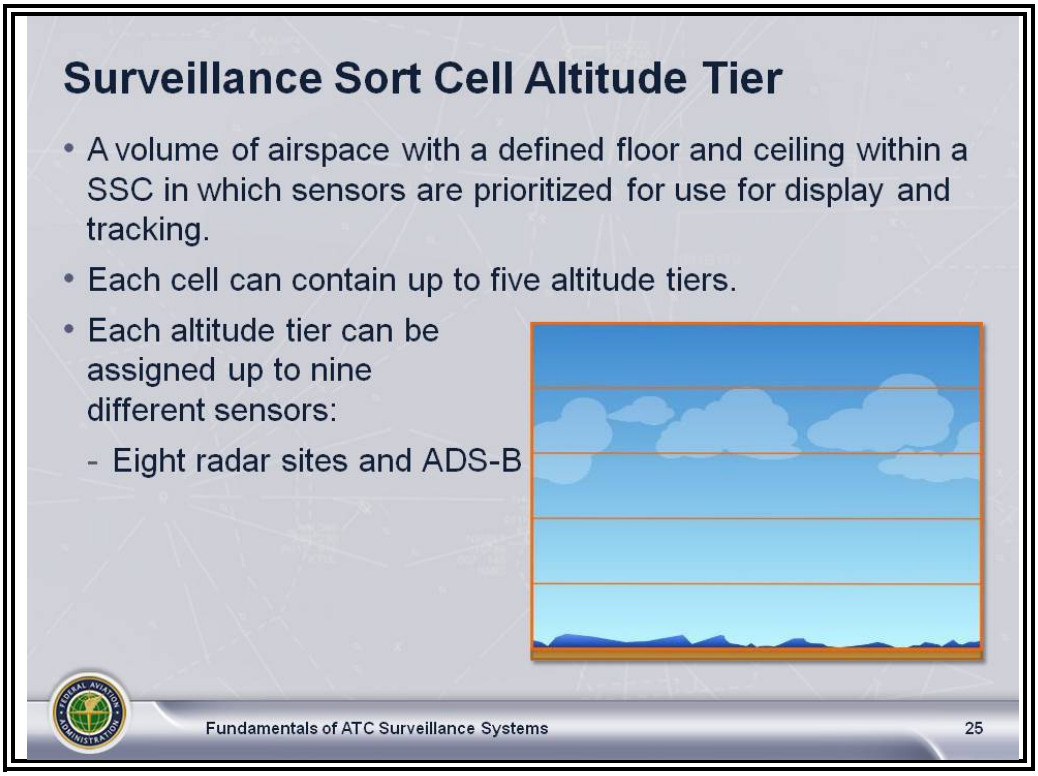
NOTE: Grids are not displayed on the Situation Display.

⊙ Targets within a grid may be detected by one or more sensors.

Continued on next page

DIGITIZED RADAR SYSTEM *(Continued)*

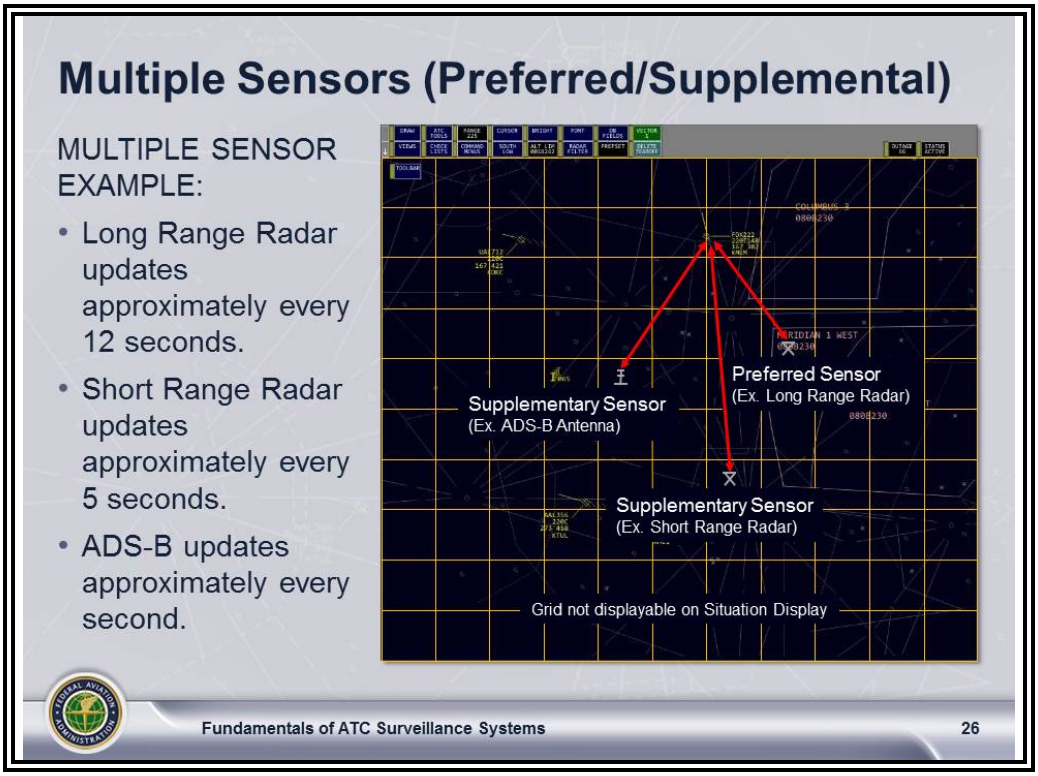
Surveillance Sort Cells (SSCs) (Cont'd)
TI 6110.141, p. 2-677 to 2-692; ERAM SURV SRS 210.24, par. 3.2.1.4.2.5; ERAM EDSM SRS 210.04 V1B1, par. 3.2.9.2.12



- Preferred and supplementary sensors are locally adaptable.
  - Determined by the best coverage within a sort box
- SSCs may have up to 5 altitude tiers with up to 9 sensors for each tier:
  - Eight radar sites and ADS-B
- SSC tiers may be locally adaptable for reduced separation.
- Short range radars may be locally adapted to SSC's for use with long range radars used in ARTCCs.

ENHANCED RADAR COVERAGE

Enhanced Radar Coverage
TI 6110.100, par. 1.2.6



- Automation provides the ability to adapt an increased number of radars in a center, which enhances radar coverage.
- Automation also provides the capability to adapt several additional altitude tiers and an increased number of radars in each tier.
  - This flexibility reduces the likelihood that a radar target will be missed due to radar outages or incomplete radar coverage.
  - Improved flexibility in the definition of airspace volumes has improved the support for reduced separation areas.
- Regardless of the individual sensor update rate, targets on the Situation Display will update approximately every 12 seconds.

CONCLUSION

Summary

- Primary radar system
- Air Traffic Control Radar Beacon System (ATCRBS) - Secondary radar
- Factors that affect radar data display
- Automatic Dependent Surveillance-Broadcast (ADS-B)
- Characteristics of digitized radar systems
- Enhanced radar coverage

End-of-Lesson Test

- Your instructor will now administer the End-of-Lesson Test.