BASICS FOR AIR TRAFFIC CONTROL – ATC SURVEILLANCE SOURCES

MODULE OVERVIEW

Purpose: This module explains how the primary and secondary radar systems work and identifies their components. It will also provide the disadvantages for the secondary radar system.

MODULE OUTLINE

Lesson: Primary Radar System

Purpose: The purpose of this lesson is to identify the uses and components of primary radar.

Objectives:

- Identify uses of primary radar
- Identify components of primary radar

Topics:

- Radar and Radar Display
- Radar Weather Display
- Primary Radar
- How Primary Radar Works
- Primary Radar Components
  - Transmitter
  - Antenna
  - Receiver
  - Radar Display
- Knowledge Check
- Review/Summary

Question and Answer Session – *Parking Lot*

Lesson: Secondary Radar System

Purpose: The purpose of this lesson is to identify the uses and components of secondary radar.

Objectives:

- Identify uses of secondary radar
- Identify components of secondary radar

Topics:

- Secondary Radar
- How Secondary Radar Works
- Secondary Radar Components
  - Interrogator
  - Antenna
  - Transponder
  - Decoder
  - Radar Display

- Knowledge Check
- Advantages and Disadvantages of Secondary Radar
- Knowledge Check
- Review/Summary

Lesson: Features of Video Display

Purpose: The purpose of this lesson is to identify features of a video map on a radar display.

Objective:

- Identify features of a video map

Topics:

- Video Map
- Video Map Features
  - Airway Intersection
  - Obstruction
  - NAVAIDS
  - Airport
  - Airspace Boundary
- Knowledge Check
- Review/Summary

Question and Answer Session – *Parking Lot*

Lesson: Automatic Dependent Surveillance-Broadcast (ADS-B)

Purpose: The purpose of this lesson is to identify features of Automatic Dependent Surveillance-Broadcast (ADS-B).

Objective:

- Identify features of ADS-B

Topics:

- Features of ADS-B
- Characteristics of ADS-B
- How ADS-B Works
- ADS-B Coverage
- Levels of Aircraft Equipment
  - ADS-B-Out
  - ADS-B-In
- Knowledge Check
- Review/Summary

Activity – Radar Terminology

Question and Answer Session – *Parking Lot*

End-of-Module (EOM) Test

INTRODUCTION

LESSONS	■ Primary Radar System ■ Secondary Radar System ■ Features of Video Display ■ Automatic Dependent Surveillance-Broadcast (ADS-B)
TOTAL ESTIMATED RUN TIME	2 hr. 37 mins.
MODULE CONTENT	■ Module Overview ■ Lesson: Primary Radar System ■ Q&A Session– Parking Lot ■ Lesson: Secondary Radar System ■ Lesson: Features of Video Display ■ Q&A Session– Parking Lot ■ Lesson: Automatic Dependent Surveillance-Broadcast (ADS-B) ■ Activity – Radar Terminology ■ Q&A Session – Parking Lot ■ End-of-Module Test

FACILITATOR INSTRUCTIONS	DELIVERY METHOD
■ Instruct students to select ***Air Traffic Control (ATC) Surveillance Sources*** module link within Blackboard ■ Instruct students to read the module introduction and then wait quietly for additional instructions	Blackboard
	EST. RUN TIME
	2 mins.

Radar is a valuable tool used daily by en route and terminal air traffic controllers to locate, track, and separate aircraft. Understanding its uses, unique components, and basic concepts will increase your ability to operate as an air traffic controller in the National Airspace System (NAS).

In a nonradar environment, controllers must visualize the airspace under their control. Controllers rely on pilot reports to determine the position of aircraft and to identify areas of adverse weather.

The purpose of this module is to explain how the primary and secondary radar systems work and identify their components. It will also provide the disadvantages for the secondary radar system.

FACILITATOR INSTRUCTIONS	DELIVERY METHOD
■ **ENABLE *Primary Radar System*** lesson in Blackboard ■ Instruct students to navigate to the ***Primary Radar System*** lesson in Blackboard ■ Instruct students to work individually through the lesson content ■ Upon completion of the lesson, students should review previously introduced content or wait quietly until other students have completed	Blackboard **EST. RUN TIME** 10 mins.

PRIMARY RADAR SYSTEM

Purpose: This lesson identifies the uses and components of primary radar.

Objectives:

- Identify uses of primary radar
- Identify components of primary radar

References for this lesson are as follows:

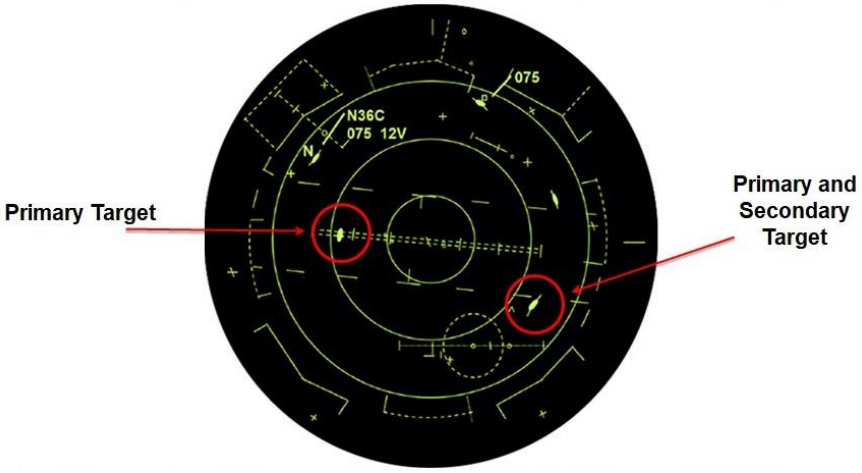
- FAA Order JO 7110.65, Air Traffic Control
- ETM 12-0-1, Fundamentals of Primary and Secondary Surveillance Radar

Radar and Radar Display

Radar is a device which, by measuring the time interval between transmission and reception of radio pulses and correlation, the angular azimuth orientation of the radiated antenna beam/beams in azimuth and/or elevation, provides information on range, azimuth, and/or elevation of objects in the path of the transmitted pulses.

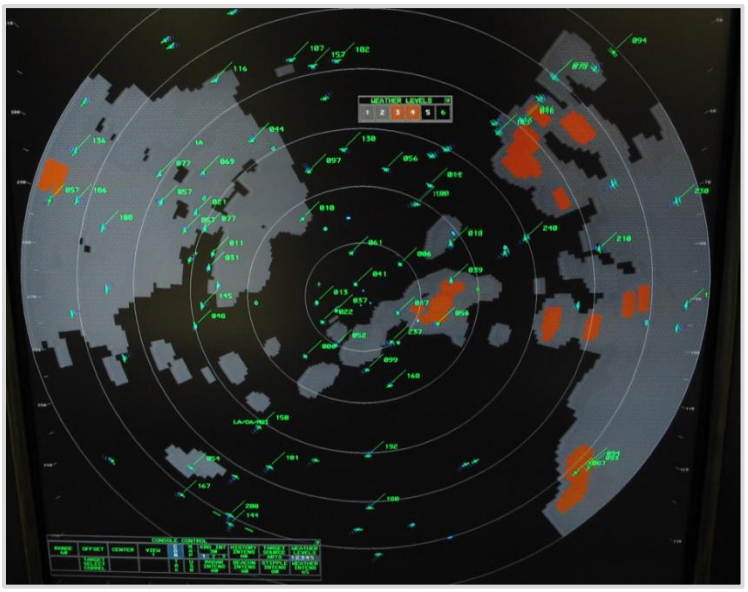
Note: *Radar is a radio detection device which provides information on range, azimuth, and/or elevation of objects.*

Instructor Note: *Use graphic to indicate examples of radar data. N36C is a correlated (or tracked) target, mode C 7,500, speed 120 knots, "V" indicates assigned beacon code is from the 1200 series (i.e. 1247). The primary/secondary target to the NNE is an unidentified 1200 code mode C 7,500.*



Radar Weather Display

Air Traffic Control (ATC) uses several different display systems, each having their own display characteristics. This is an example of a digitized radar display depicting weather.



Example of Digitized Radar Weather Display

Types of Radar Systems

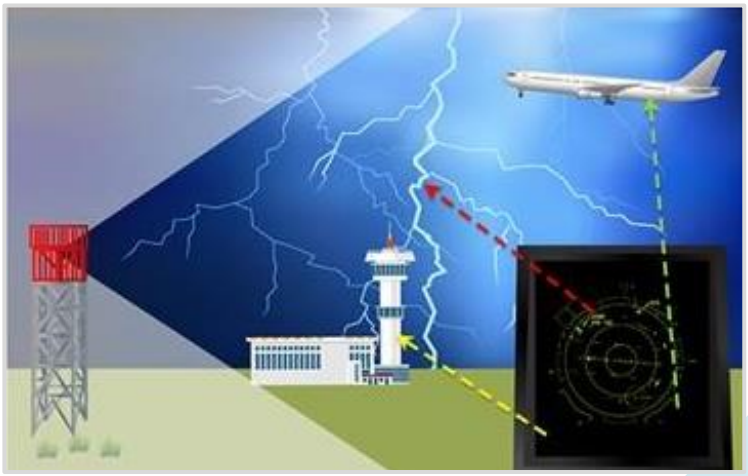
There are two types of radar; primary and secondary. This lesson only covers primary radar.

Primary Radar is a radar system in which a minute portion of a radio pulse transmitted from a site is reflected by an object and then received back at the site for processing and display at an ATC facility.

How Primary Radar Works

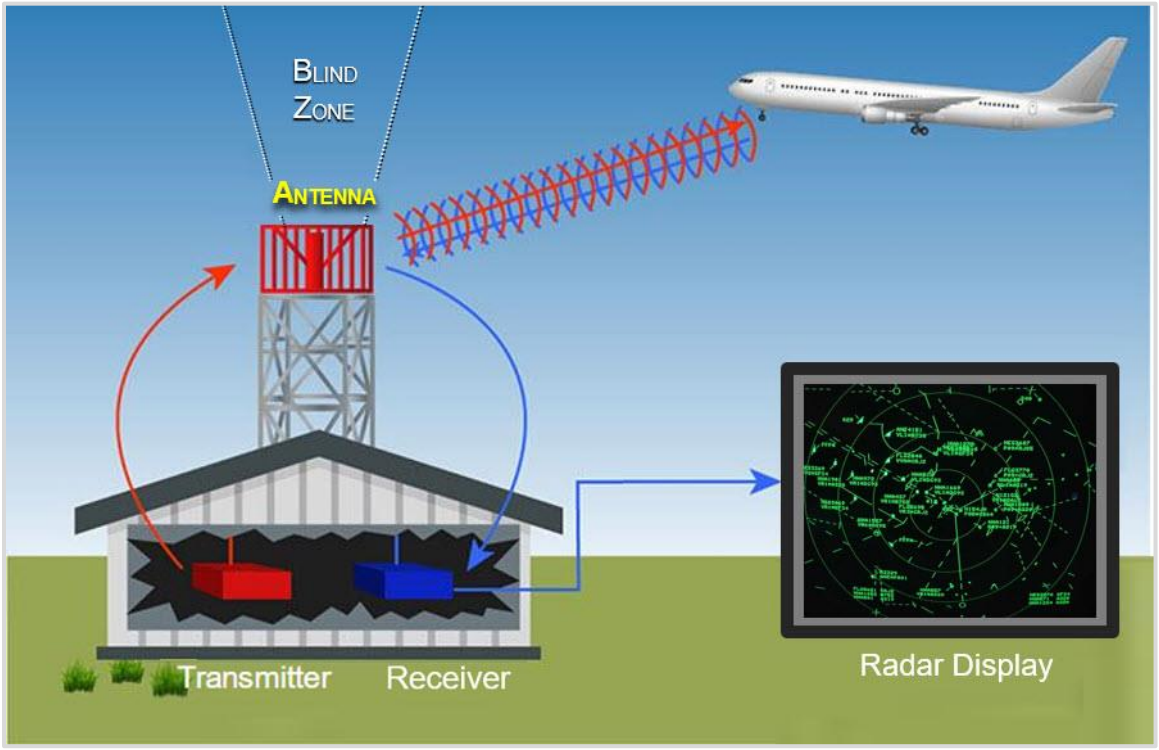
- A primary radar system sends out a signal which is reflected by anything with mass (echo principle)
  - Reflected energy is called “echo” or “target”
- The primary radar signal is a pulse of radio energy similar to an x-ray
- This reflected signal is timed, processed, and presented on a radar display
- Primary radar requires no equipment in the aircraft

Note: *Clouds, buildings, and airplanes all have mass, which reflects radar energy.*



Primary Radar Components

The four major components of a primary radar system are:



Transmitter	The **transmitter** generates a pulse of radio energy.
Antenna	The **antenna** focuses and broadcasts radio energy, then collects the reflected return. ■ The area directly above the antenna is called the **"blind zone"** and is not included in the signal pattern ■ Aircraft in the blind zone cannot be seen on the radar display
Receiver	The **receiver** amplifies and converts the reflected energy into video.
Radar Display	The **radar display** depicts the position and movement of objects that reflect radio energy.

Knowledge Check A

REVIEW what you have learned so far about primary radar system. ANSWER the questions below.

1. What type of radar display is shown in the image? *(Select the correct answer.)*
   - ❑ Radio Detection Display
   - ❑ **Digitized Radar Display Depicting Weather**
   - ❑ Primary Radar Display
   - ❑ Secondary Radar Display

2. Which of the following define how primary radar works? *(Select all correct answers that apply.)*
   - ❑ **Sends out a signal which is reflected by anything with mass**
   - ❑ **Signal is a pulse of radio energy similar to an x-ray**
   - ❑ **Requires no equipment in the aircraft**
   - ❑ **Reflected signal is timed, processed, and presented on a radar display**

3. What are the components of a primary radar system? (*Select the correct answer.)*
   - ❑ Weather display, receiver, transmitter, and target
   - ❑ Radar display, echo, antenna, and azimuth
   - ❑ **Transmitter, antenna, receiver, and radar display**

4. Which primary radar component depicts the position and movements of objects that reflect radio energy? *(Select the correct answer.)*
   - ❑ **Radar display**
   - ❑ Transmitter
   - ❑ Antenna
   - ❑ Receiver

5. Which primary radar component focuses and broadcasts radio energy, then collects the reflection return? *(Select the correct answer.)*
   - ❑ Radar display
   - ❑ Transmitter
   - ❑ **Antenna**
   - ❑ Receiver

6. Which primary radar component amplifies and converts the reflected energy into video? *(Select the correct answer.)*
   - ❑ Radar display
   - ❑ Transmitter
   - ❑ Antenna
   - ❑ **Receiver**

Primary Radar System Summary

Air traffic controllers use primary radar to detect and measure positions of aircraft. Being able to identify the system components and its uses is essential to understanding how the ATC surveillance sources contribute to helping you maintain a safe environment for aircraft.

FACILITATOR INSTRUCTIONS	DELIVERY METHOD
■ Review content presented in ***Primary Radar System*** lesson ■ Navigate to the ***Parking Lot*** link within Blackboard and review any student questions ■ Address ***Parking Lot*** questions and facilitate a brief discussion of the lesson content	Facilitated Discussion **EST. RUN TIME** 10 mins.

FACILITATOR INSTRUCTIONS	DELIVERY METHOD
■ **ENABLE *Secondary Radar System*** and ***Features of Video Displays*** lessons in Blackboard ■ Instruct students to navigate to the ***Secondary Radar System*** lesson in Blackboard ■ Instruct students to work individually through the lesson content ■ Upon completion of ***Secondary Radar System*** instruct students to navigate to the ***Features of Video Displays*** lesson in Blackboard ■ Instruct students to work individually through the lesson content ■ Upon completion of the lesson, students should review previously introduced content or wait quietly until other students have completed	Blackboard **EST. RUN TIME** 15 mins.

SECONDARY RADAR SYSTEM

Purpose: This lesson identifies the uses and components of secondary radar.

Objectives:

- Identify uses of secondary radar
- Identify components of secondary radar

References for this lesson are as follows:

- FAA Order JO 7110.65, Air Traffic Control
- ETM 12-0-1, Fundamentals of Primary and Secondary Surveillance Radar

Types of Radar Systems

There are two types of radar; primary and secondary. This lesson only covers secondary radar.

Secondary Radar/Radar Beacon is a radar system in which the object to be detected is fitted with cooperative equipment, known as a transponder.

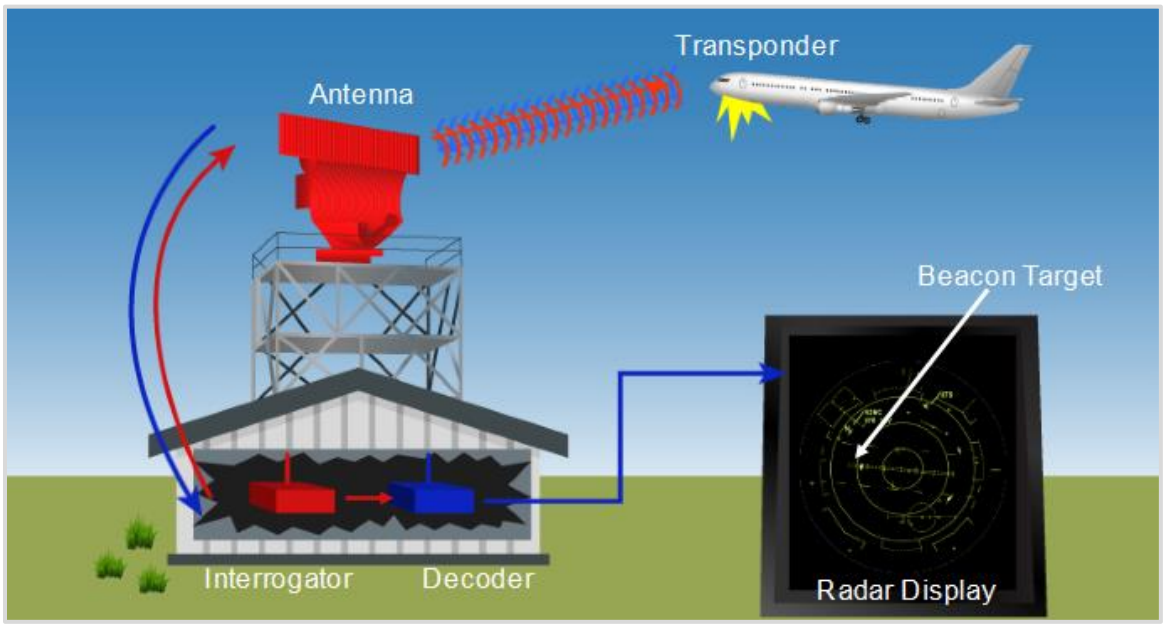
Secondary radar is sometimes referred to as Air Traffic Control Radar Beacon System (ATCRBS).

How Secondary Radar Works

Radio signals from the searching interrogator (transmitter/receiver) ground site are:

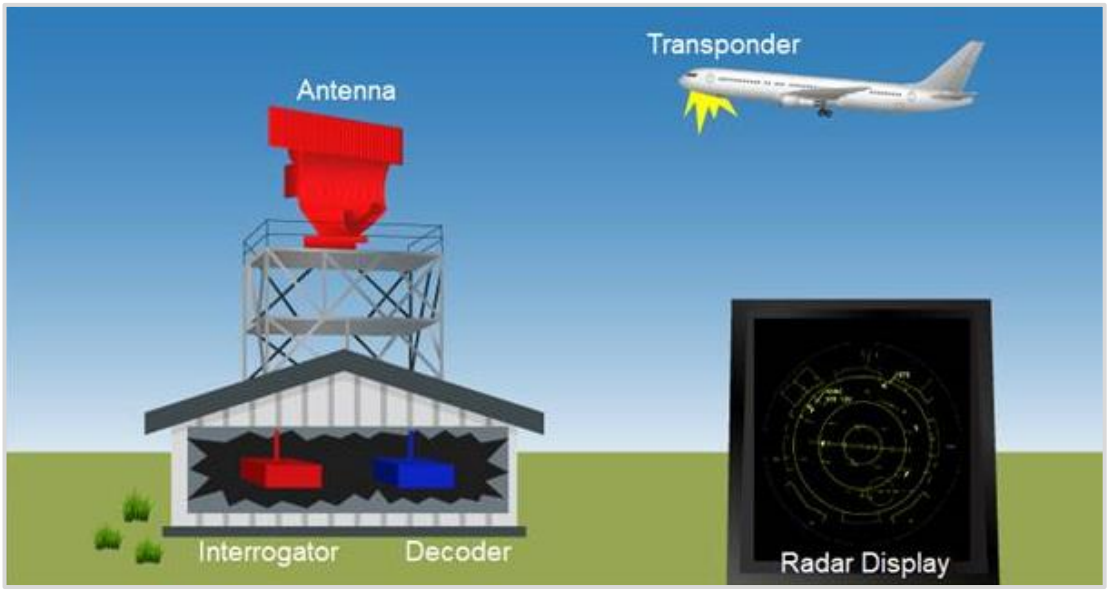
- Received by the transponder (receiver/transmitter) in the aircraft
- Used to trigger a distinctive reply signal, which is transmitted back to the interrogator

The interrogator relays the incoming signal to the decoder, where it is processed for the radar display.



Secondary Radar Components

The secondary radar system consists of five major components:



Interrogator	■ The **interrogator** is a ground-based transmitter ■ The **interrogator** generates radio signals which are sent to the antenna for broadcast • These radio signals request all transponders within range to reply
Antenna	■ The **antenna** is mounted on top of the associated primary antenna, unless it is a secondary-only site ■ Broadcasts radio signals covering the same azimuth as the primary antenna ***Note:*** *You can have secondary radar without primary radar.*
Transponder	■ The **transponder** is located on the aircraft ■ The **transponder** automatically receives the interrogator's signals and replies with the code assigned by ATC ■ The transponder reply is received by the antenna, sent to the interrogator, and relayed to the decoder

Note: *Controllers know if an aircraft is* ***transponder-equipped*** *by a coded* ***equipment suffix*** *that appears on each aircraft's flight plan. Other aircraft suffixes will be discussed in a later lesson.*

Equipment Suffixes	Additional Information
/ A	Also has Distance Measuring Equipment (DME) and altitude reporting capability
/ B	Also has DME but does not have alitude reporting capability
/ P	Equipped with TACAN and altitude reporting capability
/ I	Advanced area navigation (RNAV) equipment and altitude reporting capability
/ T	Does not have altitude reporting capability
/ U	Has altitude reporting capability

Decoder	The **decoder** processes the transponder replies and sends them to the radar display.
Radar Display	The **radar display** depicts an electronic presentation of radar-derived information.

Knowledge Check B

REVIEW what you have learned so far about secondary radar system. ANSWER the questions below.

1. Which component of the secondary radar system is located on the aircraft? *(Select the correct answer.)*
   - ❑ Decoder
   - ❑ Interrogator
   - ❑ **Transponder**
   - ❑ Radar display

2. What are the five major components of the secondary radar system? *(Select the correct answer.)*
   - ❑ Decoder, antenna, receiver, transmitter, and transponder
   - ❑ **Interrogator, transponder, antenna, decoder, and radar display**
   - ❑ Transponder, control beacon, receiver, decoder, and radar display

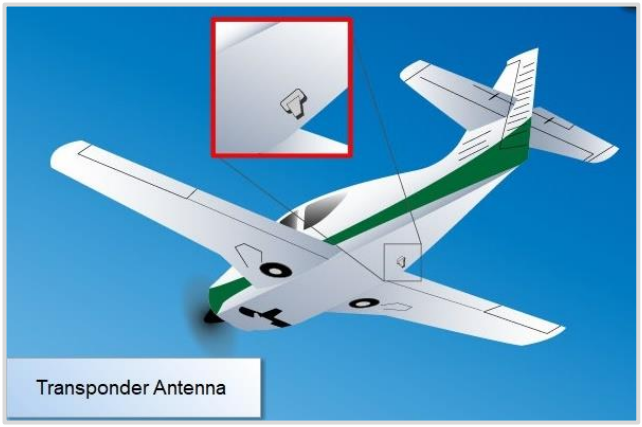
3. The _____ processes the transponder replies and sends them to the radar display. *(Select the correct answer.)*
   - ❑ Radar display
   - ❑ Interrogator
   - ❑ Antenna
   - ❑ **Decoder**

4. Which component is mounted on top of the associated primary antenna, unless it is a secondary-only site? *(Select the correct answer.)*
   - ❑ Decoder
   - ❑ **Antenna**
   - ❑ Receiver
   - ❑ Transponder

Advantages and Disadvantages of Secondary Radar

- Advantages
  - It is less vulnerable to blind spots (blind zone)
  - It provides a longer range than primary radar
  - Radar responses are not degraded by weather or ground clutter

- Disadvantages
  - It only displays aircraft with transponders
  - It does not provide weather information
  - The return is affected by the aircraft's orientation along its longitudinal axis
    - The aircraft transponder antenna is normally located on the underside of the aircraft
    - The location of the transponder antenna may cause a difference in reception if an aircraft is in a turn at an angle where the antenna is not exposed



Knowledge Check C

REVIEW what you have learned so far about advantages and disadvantage of secondary radar system. ANSWER the questions below.

1. Which of the following are advantages of a secondary radar system? *(Select all correct answers that apply.)*
   - ❑ **Not degraded by weather echoes or ground clutter**
   - ❑ **Less vulnerable to blind spots**
   - ❑ Reflected signal is timed, processed, and presented on a radar display
   - ❑ **Provides longer range**
   - ❑ All of the above

2. Which of the following are disadvantages of a secondary radar system? *(Select all correct answers that apply.)*
   - ❑ Not degraded by weather echoes or ground clutter
   - ❑ **Does not provide weather information**
   - ❑ **Return is affected by aircraft orientation**
   - ❑ **Only displays aircraft with transponders**
   - ❑ All of the above

Secondary Radar System Summary

Secondary radar is used by air traffic controllers not only to detect and measure the position of aircraft, but also to request additional information from the aircraft, such as its identity and altitude. Understanding its uses and how the components operate increases your ability to operate as an air traffic controller in the National Airspace System.

FACILITATOR INSTRUCTIONS	DELIVERY METHOD
■ **Note: *Features of Video Display*** lesson should have already been enabled in Blackboard, if not ensure it is enabled ■ Instruct students to navigate to the ***Features of Video Display*** lesson in Blackboard ■ Instruct students to work individually through the lesson content ■ Upon completion of the lesson, students should review previously introduced content or wait quietly until other students have completed	Blackboard **EST. RUN TIME** 10 mins.

FEATURES OF VIDEO DISPLAY

Purpose: This lesson identifies features of a video map on a radar display.

Objective:

- Identify features of a video map

References for this lesson are as follows:

- FAA Order JO 7110.65, Air Traffic Control
- ETM 12-0-1, Fundamentals of Primary and Secondary Surveillance Radar

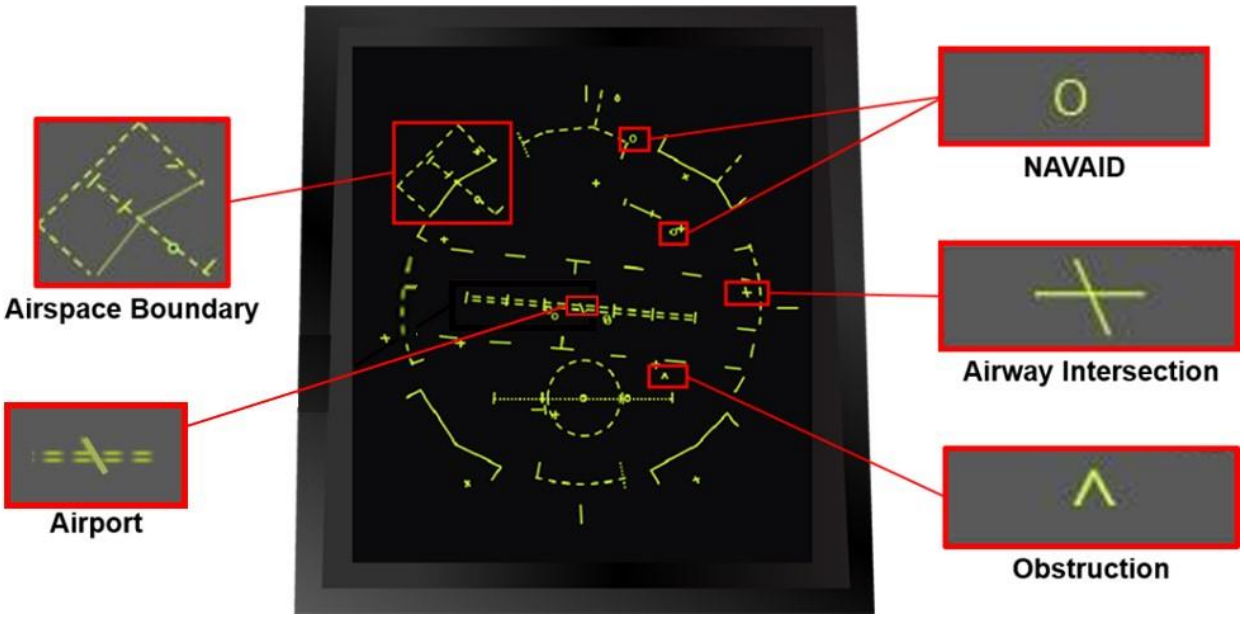
Video Map

A **video map** is an electronically displayed map on the radar display that may depict data such as:

- Airports
- Heliports
- Runway centerline extensions
- Navigational aids (NAVAIDs) and fixes
- Reporting points
- Airway/route centerlines
- Boundaries
- Handoff points
- Special use tracks
- Obstructions
- Prominent geographic features
- Range marks
- Minimum vectoring altitudes

Video Map Features

An electronic video map expands and contracts as the display range is changed.



Knowledge Check D

REVIEW what you have learned so far about features of a video display. ANSWER the questions below.

1. Identify the features used in a video map. Enter your answers in the spaces below.

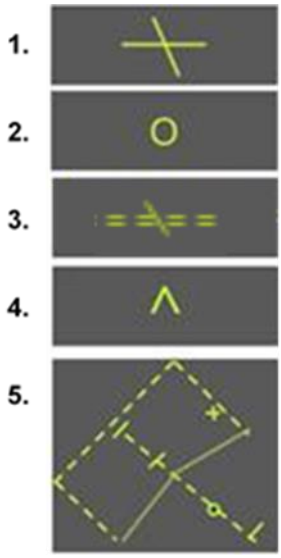
5 Airspace boundary

2 NAVAID

1 Airway intersection

4 Obstruction

3 Airport



Features of Video Displays Summary

ATC radar displays are one of the primary methods for controllers to guide aircraft. A Controller's ability to read, interpret, and decipher radar is a vital skill for separating aircraft.

FACILITATOR INSTRUCTIONS	DELIVERY METHOD
■ Review content presented in ***Secondary Radar System*** and ***Features of Video Display*** lessons ■ Navigate to the ***Parking Lot*** link within Blackboard and review any student questions ■ Address ***Parking Lot*** questions and facilitate a brief discussion of the lesson content	Facilitated Discussion **EST. RUN TIME** 20 mins.

FACILITATOR INSTRUCTIONS	DELIVERY METHOD
■ **ENABLE** ***Automatic Dependent Surveillance-Broadcast (ADS-B)*** lesson in Blackboard and ***Radar Terminology*** activity in the ***Exercises and Activity*** folder ■ Instruct students to navigate to the ***Automatic Dependent Surveillance-Broadcast (ADS-B)*** lesson in Blackboard ■ Instruct students to work individually through the lesson content ■ Upon completion of ***Automatic Dependent Surveillance-Broadcast (ADS-B)*** lesson instruct students to navigate to the ***Radar Terminology*** activity in the ***Exercises and Activity*** folder ■ Instruct students to work individually through the activity ■ At the end of the activity, the activity will evaluate the students' performance	Blackboard and Activity **EST. RUN TIME** 15 mins.

AUTOMATIC DEPENDENT SURVEILLANCE-BROADCAST (ADS-B)

Purpose: This lesson identifies features of Automatic Dependent Surveillance-Broadcast or ADS-B.

Objective:

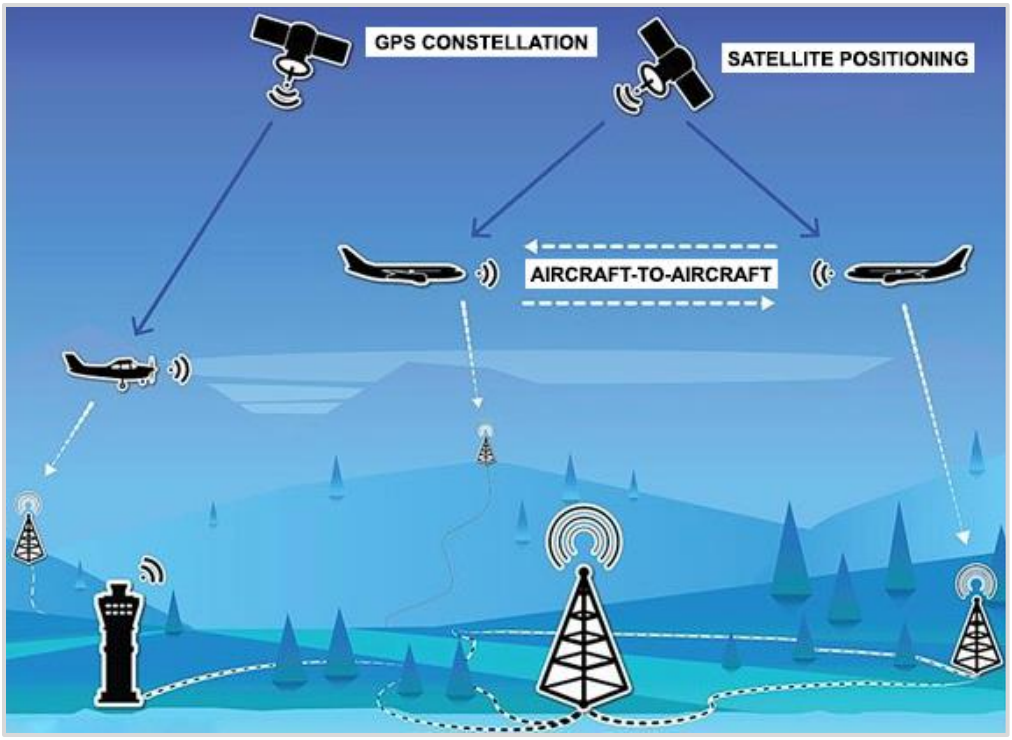
- Identify features of ADS-B

References for this lesson are as follows:

- FAA Order JO 7110.65, Air Traffic Control
- ETM 12-0-1, Fundamentals of Primary and Secondary Surveillance Radar
- www.faa.gov

Features of ADS-B

Automatic Dependent Surveillance-Broadcast (ADS-B) is a surveillance system in which an aircraft to be detected is fitted with a data link transmitter. The aircraft periodically broadcasts its Global Positioning System (GPS)-derived position, call sign, velocity, and other information over the data link. The information is received by a radio station for processing and display at an air traffic control facility.

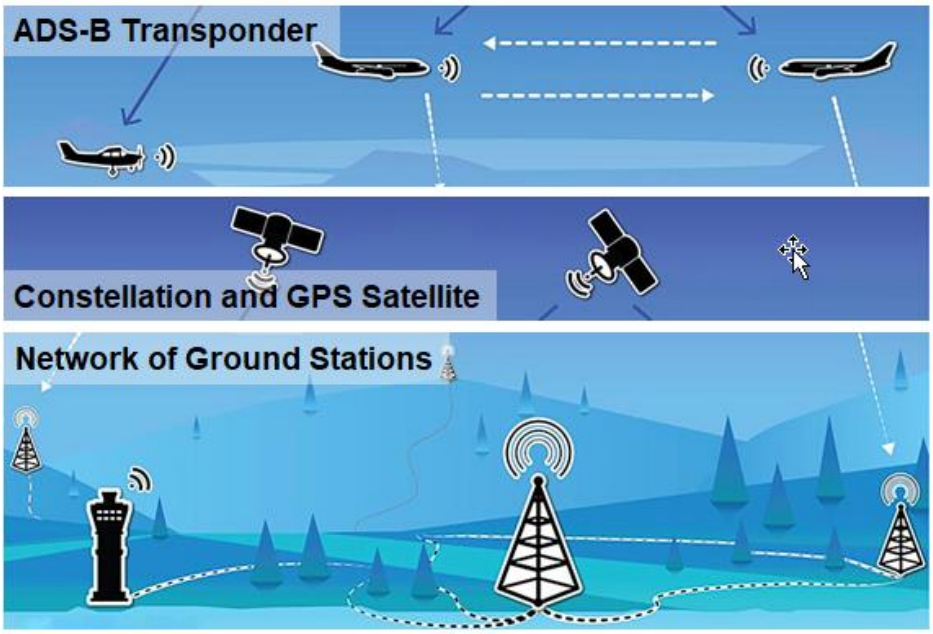


A	**Automatic** – Transmits location and other information every second with no pilot action.
D	**Dependent** – Dependent on aircraft equipped with a rule compliant position source and appropriate signal transmitter.
S	**Surveillance** – Uses Global Navigation Satellite System (GNSS) technology to provide aircraft position and altitude. Position accuracy is independent of the distance from the ground station.
B	**Broadcast** – Equipment automatically transmits data to ground stations for ATC system use and to any airborne aircraft equipped to receive information.

Characteristics of ADS-B

The ADS-B system relies on:

- ADS-B transponder
- Constellation of GPS satellites
- Network of ground stations
- Broadcast communications link

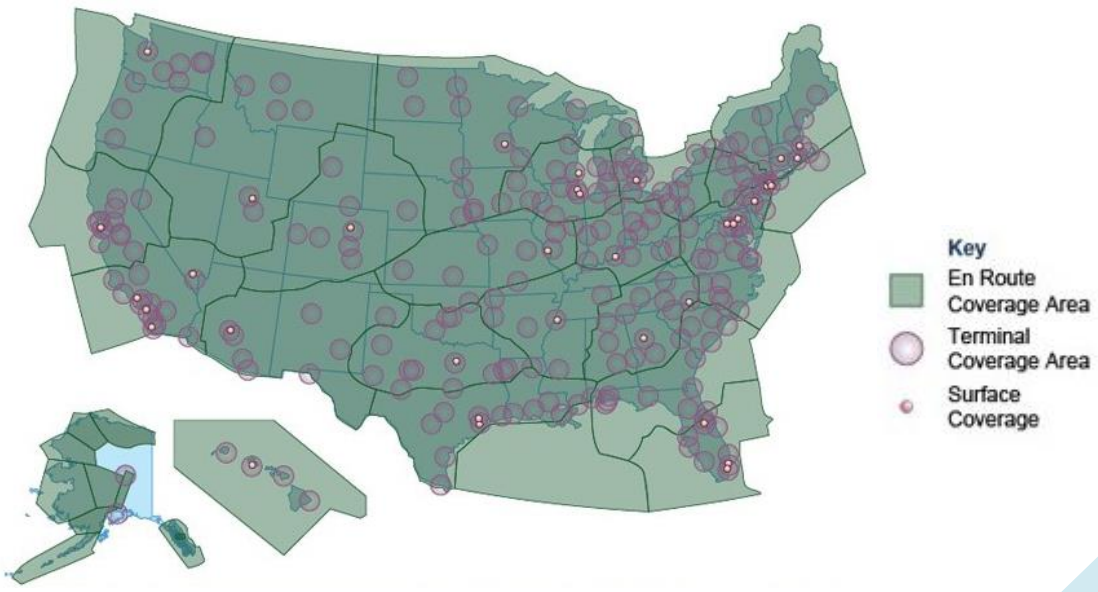


How ADS-B Works

- GPS system sends position information to aircraft
- Aircraft simultaneously broadcast position, speed, and altitude data to:
  - Ground stations
  - Other airborne aircraft with ADS-B In equipment
- Ground stations transmit information for use in ATC
- Transmissions occur every second

ADS-B Coverage

With ADS-B operational across the country, pilots in equipped aircraft now have access to services that provide a new level of safety and efficiency. ADS-B is transforming all segments of aviation. Real-time precision, shared situational awareness, and advanced applications for pilots and controllers alike, are the hallmarks of ADS-B surveillance.



Levels of Aircraft Equipment

There are two levels of aircraft equipment. They are:

ADS-B Out

ADS-B Out is a basic level of aircraft equipment that transmits an aircraft's position, ground speed, and other data to air traffic controllers and other appropriately equipped aircraft in the sky. Aircraft with this equipment do not receive position information from other ADS-B-equipped aircraft.

- Provides better radar coverage and accuracy than the current transponder/radar system
- Transmits surveillance information about an aircraft in flight or while on the ground
- Provides a more reliable radar feed to air traffic control
- Provides ATC with updated aircraft information almost every second
- Operators equipped with ADS-B Out will enjoy more efficient spacing and optimal routing in nonradar environments

Note: *The FAA has mandated that aircraft operating in most controlled U.S. airspace be equipped for ADS-B Out by January 1, 2020. The highly precise GPS-based surveillance provided by ADS-B Out also improves the ability to perform life-saving search and rescue (SAR) missions.*

ADS-B In

ADS-B In equipment allows aircraft, when equipped properly, to receive and interpret other participating aircraft's ADS-B Out data on a computer screen or an Electronic Flight Bag in the cockpit. General aviation operators who equip also benefit from free real-time graphical weather and other aeronautical information sent directly to the cockpit. ADS-B In-equipped aircraft have access to:

Flight Information Service–Broadcast (FIS-B):

- Broadcasts:
  - Graphical weather to the cockpit
  - Notices to Air Missions (NOTAMs) such as Temporary Flight Restrictions (TFRs) or closed runways as text-based advisories
  - Significant weather activity as text-based advisories
  - Access to terrain maps

Traffic Information Service-Broadcast (TIS-B):

- Provides pilots information concerning:
  - Altitude, ground track, speed
  - Distance of aircraft flying in radar contact with controllers and within 15-nautical mile (NM) radius, up to 3,500 feet above or below the receiving aircraft's position

Note: *These ADS-B In pilot advisory services are provided at no cost to the user. Similar to the view that air traffic controllers observe on their displays, pilots of ADS-B In-equipped aircraft have cockpit displays where they can see the location of surrounding aircraft and graphic weather.*

Knowledge Check E

REVIEW what you have learned so far about automatic dependent surveillance-broadcast. ANSWER the questions below.

1. ADS-B is a surveillance system in which the aircraft is fitted with cooperative equipment in the form of a _____. *(Select the correct answer.)*
   - ❑ **ADS-B transponder**
   - ❑ Navigation system
   - ❑ Flight management system

2. The ADS-B system relies on information from _____. *(Select all correct answers that apply.)*
   - ❑ **Ground stations**
   - ❑ **ADS-B transponder**
   - ❑ Internet communications
   - ❑ **GPS satellites**

3. How does ADS-B information reach ATC? *(Select the correct answer.)*
   - ❑ Aircraft sends info to GPS; GPS sends info to ground stations; ground stations send info to ATC
   - ❑ Ground stations send info to GPS; GPS sends info to aircraft; aircraft sends info to ATC
   - ❑ **GPS sends info to aircraft; aircraft sends info to ground stations; ground stations send info to ATC**

4. Which feature does ADS-B In offer that ADS-B Out does not? *(Select the correct answer.)*
   - ❑ Provides better area coverage and accuracy than the current transponder/radar system
   - ❑ **Receives position information from other ADS-B-equipped aircraft**
   - ❑ Transmits surveillance information about an aircraft in flight or while on the ground

Automatic Dependent Surveillance Broadcast (ADS-B) Summary

NextGen is a monumental, historic shift to modernize the U.S. air transportation system. Automatic Dependent Surveillance-Broadcast is one of the key components of NextGen. This system creates a safer, more efficient National Airspace System for pilots and their passengers.

FACILITATOR INSTRUCTIONS	DELIVERY METHOD
■ **Note: *Radar Terminology*** activity should have already been enabled in Blackboard, if not ensure it is enabled ■ Instruct students to navigate to the ***Exercises and Activities*** folder in Blackboard ■ Instruct students to locate student activity ***Radar Terminology*** ■ The activity will be performed individually ■ Instruct students to answer each question ■ At the end of the activity, the activity will evaluate the students' performance ■ Suggest allowing opportunities to repeat the activity during periods of down time	Activity **EST. RUN TIME** 20 mins.

ACTIVITY: RADAR TERMINOLOGY (ANSWER KEY)

Note: *The questions in the key and their distractors may appear in a different order than displayed here due to activity question randomization.*

Question	Answer
1. Identify the major components of a primary radar system.	1. **Antenna** 2. **Transmitter** 3. **Receiver** 4. **Radar Display**
2. Identify the description of the components with the component for the primary radar system.	1. **Focuses, broadcasts, and collects reflected radio energy** 2. **Generates a pulse of radio energy** 3. **Amplifies and converts reflected radio energy into video** 4. **Depicts the position and movement of objects that reflect radio energy**
3. Identify the major components of a secondary radar system.	1. **Interrogator** 2. **Antenna** 3. **Transponder** 4. **Decoder** 5. **Radar Display**
4. Identify the description of the components with the component for the secondary radar system.	1. **Generates radio signals** 2. **Broadcasts radio signals** 3. **Automatically receives the signals and replies with the code** 4. **Processes the transponder replies** 5. **Depicts an electronic presentation of radar-derived information**
5. Match the features used on a video map.	1. **Airway intersection** 2. **NAVAID** 3. **Airport** 4. **Obstruction** 5. **Airspace boundary**
6. Identify each description of the ADS-B acronym. Reliant on aircraft equipped with a rule compliant position source and appropriate signal transmitter Uses GNSS technology to provide aircraft position and altitude Transmits data to ground stations for ATC system use and to other equipped airborne aircraft Transmits location and other information every second with no pilot action	**Dependent** **Surveillance** **Broadcast** **Automatic**

SUMMARY

This module explained how primary and secondary radar systems and Automatic Dependent Surveillance Broadcast (ADS-B) work, and identified each system's components. It also provided the disadvantages for the secondary radar system.

In accordance with www.faa.gov, FAA Order JO 7110.65, Air Traffic Control, and ETM 12-0-1, Fundamentals of Primary and Secondary Surveillance Radar, you should now be able to:

- Identify uses and components of primary radar
- Identify uses and components of secondary radar
- Identify features of a video map
- Identify features of ADS-B

FACILITATOR INSTRUCTIONS	DELIVERY METHOD
■ Navigate to the ***Parking Lot*** link within Blackboard and review any student questions ■ Address ***Parking Lot*** questions and facilitate a brief discussion of the lesson content ■ Instruct students to prepare for the End-of-Module test by putting away their Student Guides	Facilitated Discussion **EST. RUN TIME** 15 mins.

FACILITATOR INSTRUCTIONS	DELIVERY METHOD
■ **ENABLE *ATC Surveillance Sources End-of-Module Test*** link in Blackboard ■ Instruct students: ○ Clear desks ○ Do not write anything during or after the test ○ Navigate to the ***ATC Surveillance Sources End-of-Module Test*** link in Blackboard ○ Once they are satisfied with their responses, click "Save and Submit;" do not click "OK" to review results until directed to do so ○ Choose "Cancel" if they receive a warning message that the test has unanswered questions; choosing OK will submit the test and not allow them to go back and answer the questions ○ Leave the room after submitting the test and return at the "Be Back" time ■ ***Note:*** *This test is scored but not graded* ■ During test, monitor students to ensure a secure testing environment ■ Identify the most commonly missed questions by reviewing student statistics in Blackboard ■ Instruct students to click "View Results" when ready to review commonly missed questions ■ Review commonly missed questions with students	Blackboard Assessment **EST. RUN TIME** 20 mins.

END-OF-MODULE TEST (ANSWER KEY)

Note: *Test questions in Blackboard are presented to the students in random order. Please be aware the test key question order will not match the student version.*

1. Which radar system transmits from a site, is reflected by an object, and then is received back at the site for processing and display at an ATC facility? *(Select the correct answer.)*
   - ❑ **Primary radar**
   - ❑ Secondary radar
   - ❑ ADS-B
   - ❑ Primary and secondary

   Reference(s): JO 7110.65, Pilot/Controller Glossary

2. Which primary radar component focuses and broadcasts radio energy, then collects the reflected return? *(Select the correct answer.)*
   - ❑ **Antenna**
   - ❑ Receiver
   - ❑ Interrogator
   - ❑ Transmitter

   Reference(s): ETM 12-0-1

3. What does a radar display depict? *(Select the correct answer.)*
   - ❑ **Position of objects**
   - ❑ Type of aircraft
   - ❑ Beacon code
   - ❑ Altitude of aircraft

   Reference(s): JO 7110.65, Pilot/Controller Glossary

4. Where is the transponder located? *(Select the correct answer.)*
   - ❑ **Aircraft**
   - ❑ ATC tower
   - ❑ On antenna
   - ❑ On runway

   Reference(s): JO 7110.65, Chap. 2

5. Which of the following would **NOT** be a type of data depicted on a radar display? *(Select the correct answer.)*
   - ❑ **Runway lighting**
   - ❑ Boundaries
   - ❑ Obstructions
   - ❑ Airports

   Reference(s): ETM 12-0-1

6. Which of the following elements does the ADS-B system rely on to function? *(Select the correct answer.)*
   - ❑ **All of the answers**
   - ❑ Network of ground stations
   - ❑ ADS-B transponder
   - ❑ Constellation of GPS satellites

   Reference(s): JO 7110.65, Pilot/Controller Glossary