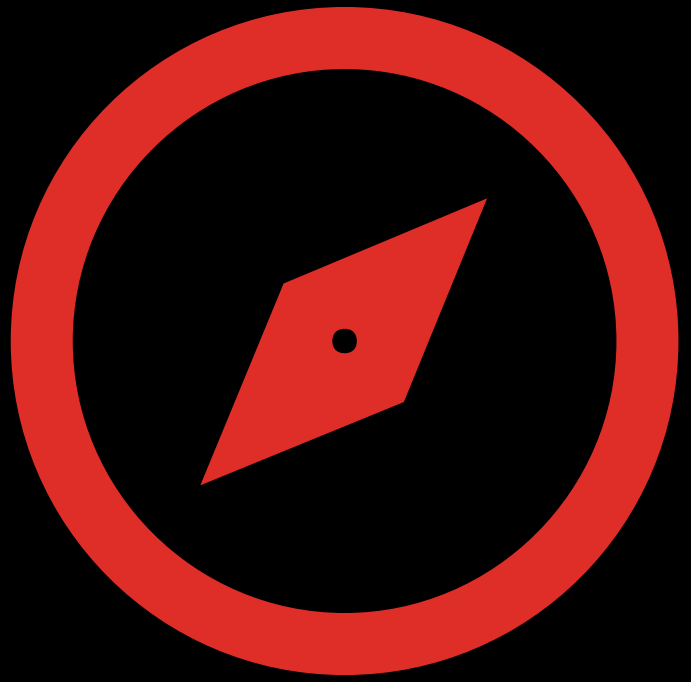


NAVIGATION AIDS: GPS

LESSON OUTLINE

LESSON OBJECTIVE

To determine that the student exhibits instructional knowledge of the elements related to navigation aids: GPS by describing the elements on the following slide.

LESSON SOURCE(S)

Pilot's Handbook of Aeronautical Knowledge
FAA-H-8083-25

Aeronautical Information Manual

LESSON OUTLINE

LESSON ELEMENTS	TIMEFRAME	EQUIPMENT/TOOLS
Satellite Based Navigation GPS Functionality RAIM and FDE Sensitivity Modes GPS Errors WAAS and LAAS	30 Minutes *approximately* Discuss Objectives Present and Review Material Student Questions Conclusion and Quiz	Lesson Presentation Whiteboard and Markers FAA Sources and References

LESSON OUTLINE

INSTRUCTOR ACTIONS	STUDENT ACTIONS	COMPLETION STANDARDS
Present Objectives and Standards Teach Lesson from Presentation Ask and Answer Student Questions Assign Homework Check Student's Post Lesson Quiz	Participate in Lesson Take Notes Ask and Respond to Questions Pass the Post Lesson Quiz	Student is able to understand and differentiate between the different lesson elements. Student is further able to apply this acquired knowledge in flight training/flight operation scenarios effectively and appropriately.

SATELLITE BASED NAVIGATION

GPS Navigation

GPS stands for “Global Positioning System” and can be used to provide satellite navigation to pilots in flight.

The Numbers

Recent advances have made GPS Navigation very reliable. This is due to its consistency and accuracy. The GPS System consists of 24 satellites that orbit the Earth around 6 different Orbital Planes. This means there are 4 satellites on each orbital plane.

SATELLITE BASED NAVIGATION

GPS Navigation

GPS stands for “Global Positioning System” and can be used to provide satellite navigation to pilots in flight.

Information Relayed

GPS Satellites relay three pieces of information to the aircraft’s on-board GPS Receiver. This information is then used by the GPS Receiver to calculate the aircraft’s position in space.

1. ID (Number/Name)
2. Position (LAT/LONG)
3. Time Code (Atomic Clock)

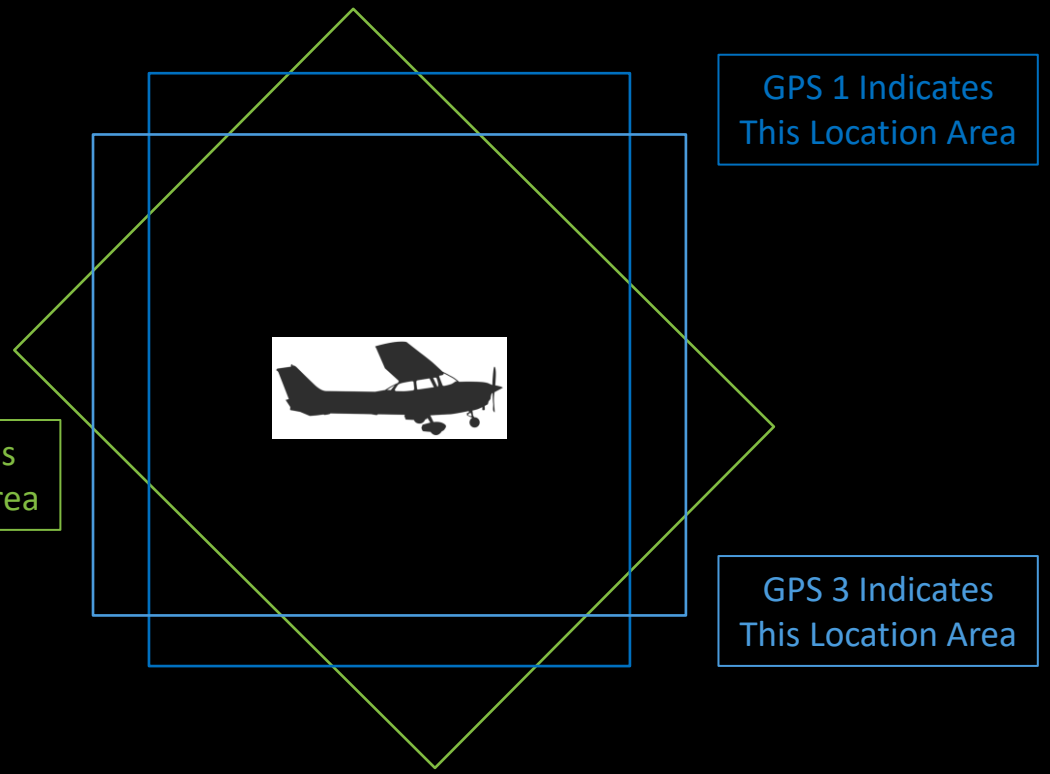
SATELLITE BASED NAVIGATION

GPS Navigation

GPS stands for “Global Positioning System” and can be used to provide satellite navigation to pilots in flight.

Calculating Position

With this information, our GPS Receiver can begin to narrow down the areas in which we are located. The more information our receiver gains from the satellites, the more accurate the position will be.



SATELLITE BASED NAVIGATION

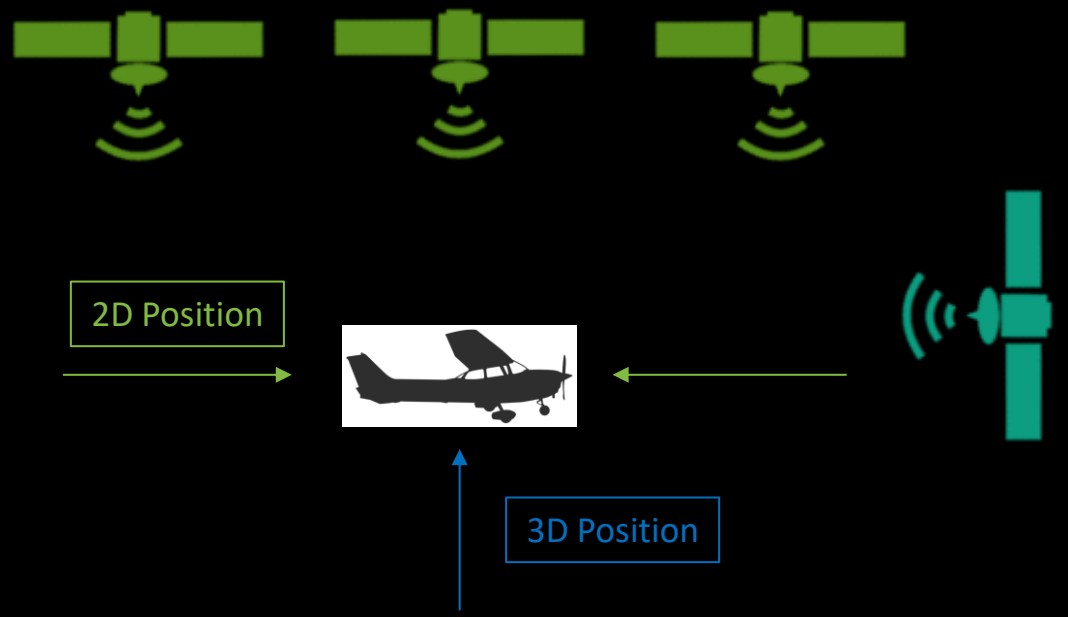
GPS Navigation

GPS stands for “Global Positioning System” and can be used to provide satellite navigation to pilots in flight.

Calculating Position

How many satellites does our GPS receiver need to be in contact with?

- Calculate a 2D (LAT/LONG) Position = 3
- Calculate a 3D (LAT/LONG and Altitude) = 4
- Calculate RAIM = 5
- Fault Detection and Exclusion = 6



SATELLITE BASED NAVIGATION

GPS Navigation

GPS stands for “Global Positioning System” and can be used to provide satellite navigation to pilots in flight.

RAIM

RAIM stands for “Receiver Autonomous Integrity Monitoring.” RAIM is the capability of a GPS Receiver to perform integrity monitoring on itself by ensuring available satellite signals meet the integrity requirements for a given phase of flight. Without RAIM, a GPS Receiver will display an “INTEG” message. This means the pilot has no assurance of GPS Position Integrity and must begin navigating through a different navigation source.

SATELLITE BASED NAVIGATION

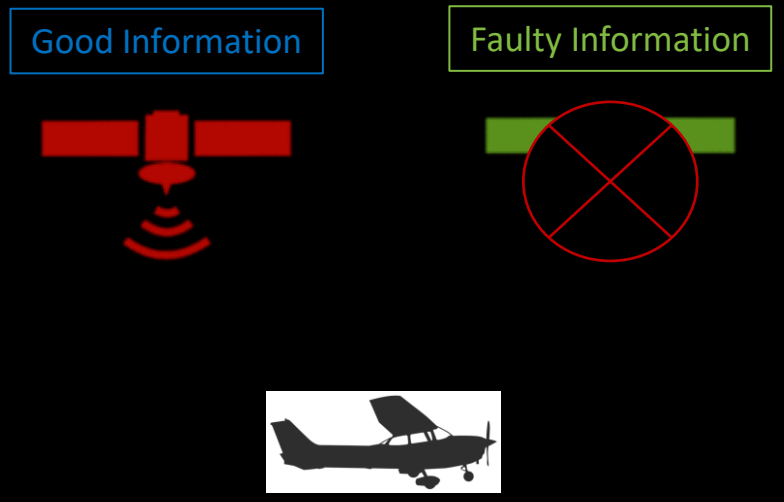
GPS Navigation

GPS stands for “Global Positioning System” and can be used to provide satellite navigation to pilots in flight.

FDE

FDE stands for “Fault Detection and Exclusion.” It is the ability of a GPS Receiver to exclude faulty satellite information.

Example: Let’s say our GPS Receiver is receiving signals from 10 GPS Satellites. Now, let’s assume one of those 10 satellites begins giving faulty information. At this point, a GPS without FDE would give the pilot an INTEG message and the pilot would no longer be able to navigate via GPS. However, if the GPS is equipped with FDE, it can exclude the information from the faulty satellite and the pilot can continue navigating via GPS.



SATELLITE BASED NAVIGATION

GPS Navigation

GPS stands for “Global Positioning System” and can be used to provide satellite navigation to pilots in flight.

Sensitivity Modes

Aircraft GPS Units typically utilize three different Sensitivity Modes. This is referring to the sensitivity of the CDI Needle and how far a pilot can be off a chosen course before the CDI has gone full deflection. They are: En-Route, Terminal, and Approach Modes.

SATELLITE BASED NAVIGATION

GPS Navigation

GPS stands for “Global Positioning System” and can be used to provide satellite navigation to pilots in flight.

En-Route

When more than 30NM from both the Departure and Destination Airports.

Sensitivity = 2NM either side of Centerline.

Terminal

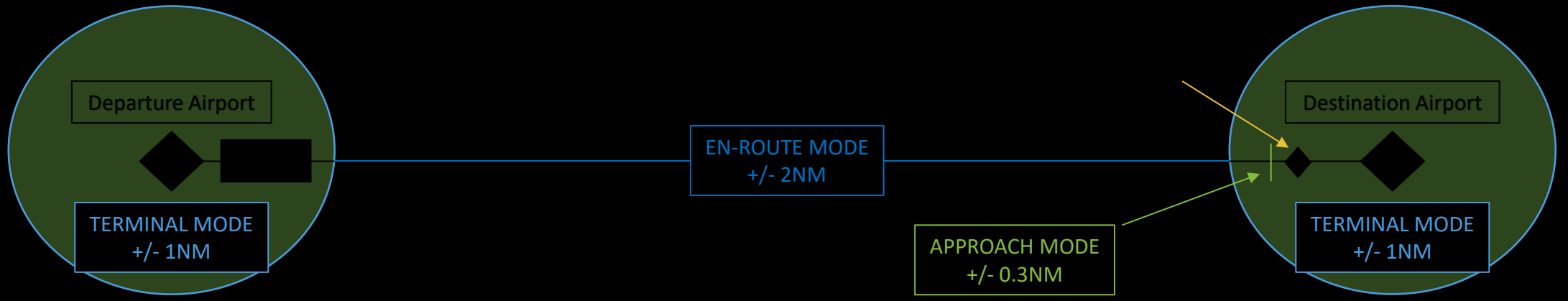
When within 30NM of either the Departure or Destination Airports.

Sensitivity = 1NM either side of Centerline.

Approach

When within 2NM of the FAF At the Destination Airport.

Sensitivity = 0.3NM either side of Centerline.



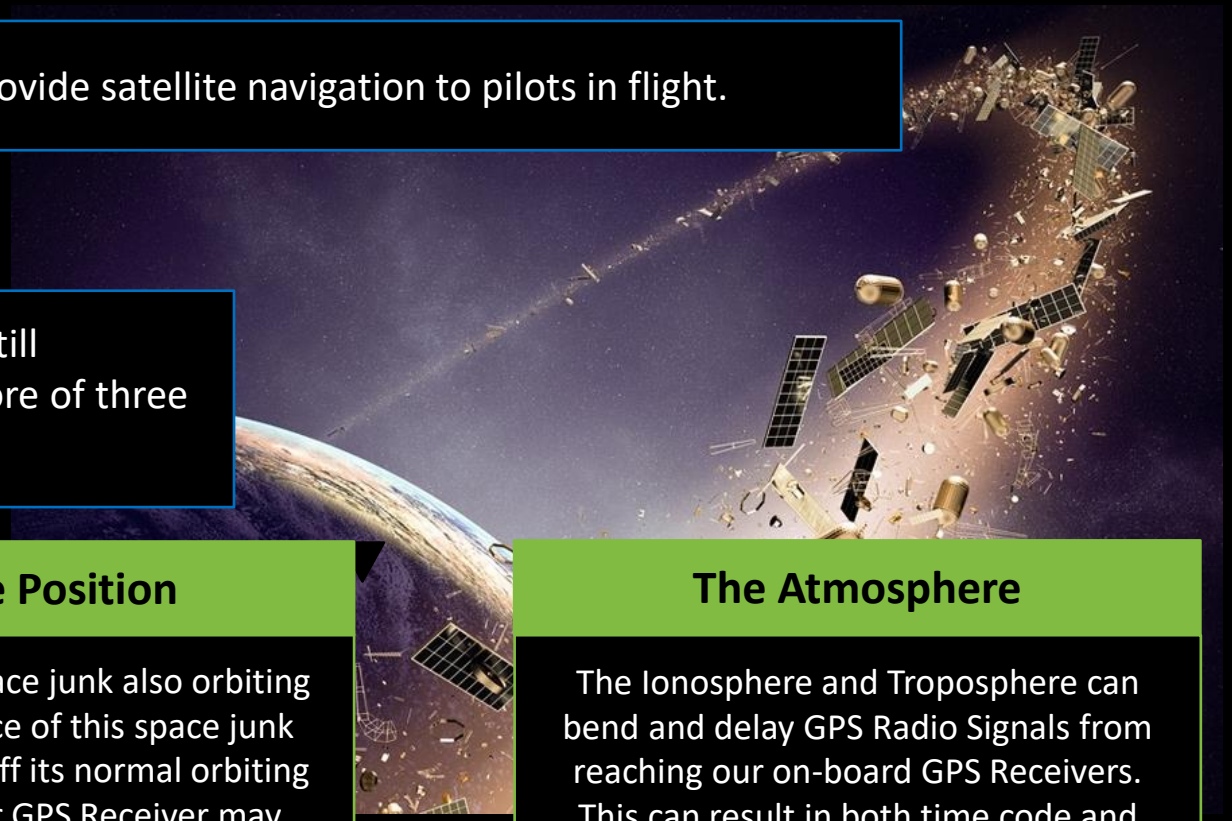
SATELLITE BASED NAVIGATION

GPS Navigation

GPS stands for “Global Positioning System” and can be used to provide satellite navigation to pilots in flight.

GPS Errors

As reliable as GPS Navigation has become in recent years, it can still experience errors. Errors in GPS Navigation come from one or more of three main sources.



Atomic Clock

An Atomic Clock is a clock that is accurate to the 1 Billionth of a Second. Therefore, if a time code sent by a GPS Satellite is 5 Billionths of a second inaccurate then our GPS position can be off by up to 5 feet.

Satellite Position

There is a lot of space junk also orbiting the Earth. If a piece of this space junk knocks a satellite off its normal orbiting position then our GPS Receiver may receive faulty information from that satellite.

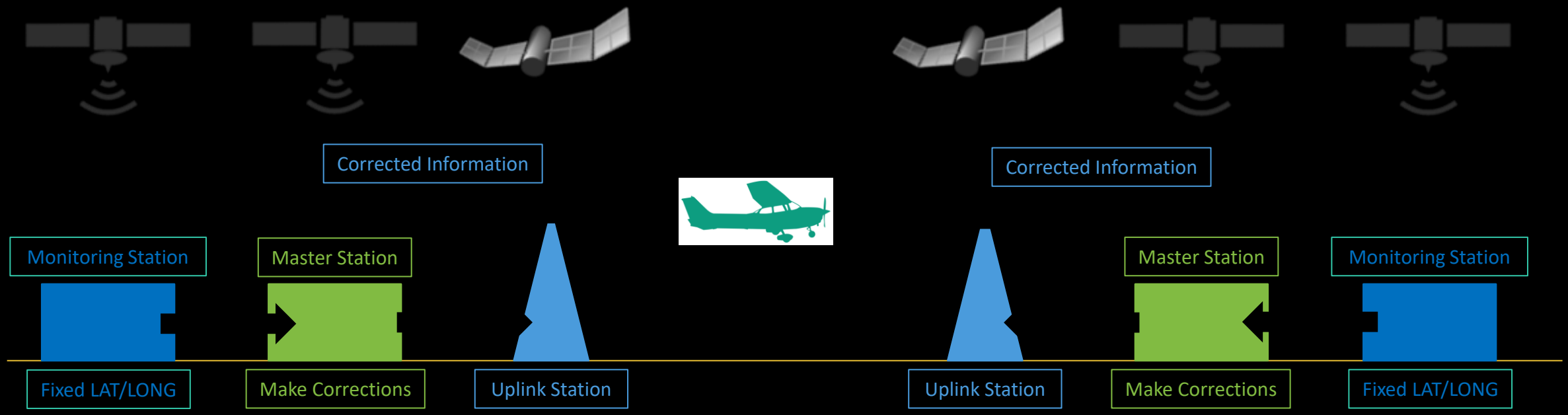
The Atmosphere

The Ionosphere and Troposphere can bend and delay GPS Radio Signals from reaching our on-board GPS Receivers. This can result in both time code and position errors.

SATELLITE BASED NAVIGATION

WAAS

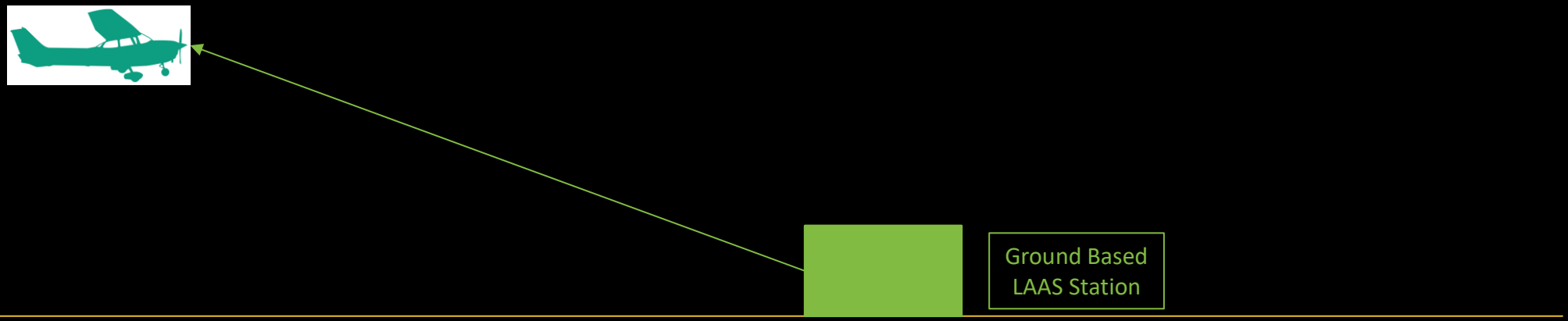
To combat these GPS errors and provide more reliable GPS information to pilots, the FAA has come up with WAAS. WAAS stands for “Wide Area Augmentation System” and it monitors the GPS satellites for errors, corrects those errors, and re-upload them to Geo-Stationary Satellites to be relayed to aircraft in flight.



SATELLITE BASED NAVIGATION

LAAS/GBAS

In recent years, the FAA has taken WAAS one step further. Ground stations (essentially ground based satellites) have been placed at certain airports that are able to accurately measure an aircraft's altitude above the surface (as they are signaling from below). This makes the vertical guidance of GPS extremely accurate.



LESSON SUMMARY

- In this lesson we discussed satellite based navigation system – GPS. We discussed how the GPS System works, what it consists of, its errors, and the steps the FAA has taken to advance its accuracy and reliability.