CIVIL AIR PATROL

INTRO TO SPACE

STK LESSON PLAN THREE:

PLACING A SATELLITE IN ORBIT

PART II - STK SCENARIOS

This portion of the lesson plan illustrates the launch concepts you have learned about in Part 1. To do this, you will run two self-guided scenarios using STK/VO software. As you recall, the major concepts introduced in Part 1 were:

1. Boosters lift satellites to orbit by overcoming the earth's gravitational pull. In the U.S. inventory, there are six booster types capable of carrying satellites of varying weight to different desired obits.
2. The initial desired orbit is a function of launch location latitude and the earth's rotation.
3. The Hohmann transfer is a process to change the shape of an orbit.

The instructions below are a step-by-step guide to help you view and understand the scenarios. If more specific information is needed, refer to Appendix A.

Scenario One

Scenario One will help you visualize the locations of the two U.S. launch sites and the Cape Canaveral Air Force Station (CCAFS) safety zone. To run the scenario, complete the following steps:

1. Load the file **Scenario\Lesson2\location\location.sc**
2. Select the **VO** map and maximize the screen.
3. Position the North American continent in the center.
4. Expand the globe until the word **shuttle** appears near the east coast of Florida.
   - Visible is the **CCAFS** launch facility. Depicted in blue, is its associated safety zone for a simulated shuttle launch. When the scenario is initiated, observe the shuttle launch azimuth. Also, observe the earth's rotation and how it enables the shuttle to travel over water before it achieves orbit. The safety zone appears to move with the shuttle flight.
5. Select **START.**

   At time **02:30**, select **PAUSE.**
   - **VAFS** is now visible. If we were to launch the shuttle from **VAFS** using the same trajectory, it would fly over land to achieve its orbit. A flight trajectory over land is not permitted within the U.S. Thus, **VAFS** would not be used to launch the shuttle into this type of orbit.
6. Select **2D** map. The **CCAFS** and **VAFS** launch sights are visible.
7. On the same map, magnify the area around the **CCAFS** area using the **ZOOM**

icon on the tool bar as follows:

- Click the icon that resembles a magnifying glass with a + (plus) sign.
- Click and hold the left mouse button and drag a rectangle around **CCAFS.**
- Release the left mouse button. The area around **CCAFS** has been enlarged.

8. Select the **RESET** and the **START** button.
   - A shuttle initial trajectory will be visible. Notice the shuttle flight path is well inside the safety zone.
9. Run the scenario as often as needed. When complete select **PAUSE.** Close out according to the instructions in **STARTING AND USING SATELLITE TOOL KIT.** Do not save the file.

SCENARIO TWO

Scenario Two helps you visualize the Hohmann transfer process. The scenario will illustrate a slightly inclined, low earth orbit changing to a equatorial geosynchronous orbit. Additionally, the scenario will illustrate the satellite's increased field of view as it moves from LEO to GEO altitude. To run the scenario, complete the following steps:

1. Load **Scenario\Lesson2\hohmann\Hohmann.sc**
2. Select the **VO** map and maximize the screen.
3. Expand the earth until the North and South Poles are approximately 2 inches from the top and bottom of the window. Then orient the globe until the tip of the African continent is at the six o'clock position. Select **RESET**.

- At a first glance, three items are visible to you: a GEO satellite **(Geobird)** at the two o'clock position; an orbit path slightly inclined; and a second orbit path parallel to the equator.
- The inclined orbit path represents the satellite's path in a LEO orbit. Since, the orbit is close to the surface of the earth, the satellite's FOV is small. The FOV is depicted by the grayish cone.
- At the nine o'clock position, observe the intersection of the orbit paths. The intersection represents the Hohmann transfer (plane change) from a LEO to a GEO.

4. Select **START**.

   At time **01:25**, select **PAUSE.**

   - Observe the satellite coming into view from the west. It is still in a LEO orbit at this point.

5. **Step** animation forward to time **01:31**. Rotate the earth until the **Geobird** is in view.

   - At this point, the **Geobird** satellite has simulated a Hohmann transfer, or a plane change. It will travel the path along the bottom orbit until it hits GEO altitude. Resume the animation by pressing **START**.

   At time **01:58**, select **PAUSE.**

   - Observe the cone size increasing as the altitude increases.

6. **Zoom out** until the top of the GEO orbit is visible. The **Geobird** icon should also be visible.

7. Select **START.**

At time **02:52,** select **PAUSE.**

- The **Geobird** satellite is at GEO altitude.
- Observe the FOV cone is at its largest, nearly covering one-third of the earth. The cone positioned over Africa and the Middle East will always be in view of the satellite. Resume animation by selecting **START**.

8. Run the scenario as often as needed. When complete select **PAUSE.** Close out according to the instructions in **STARTING AND USING SATELLITE TOOL KIT.** Do not save the file.

PART III - STUDENT PROBLEM

This portion of the lesson plan provides an opportunity for you to apply the concepts you have learned in Part I and Part II by solving a problem.

PROBLEM:

The problem is to generate an initial launch of an actual Delta mission, **SKYNET_4D**. To run the scenario, complete the following steps:

1. On the **Satellite Tool Kit** window, select **File**, then **Scenario Manager** from the draw down menu
2. Select **Create a New Scenario** on the **Start Up for Application-STK** window.
3. Select the **Satellite Tool Kit** window at the bottom of the viewer.
4. Select the **Create New Launch Vehicle** from the icon bar on the left side. This is the 9th icon from the top, and it resembles a rocket on a launch pad.
5. Change the name of the launch vehicle from **LaunchVehicle1** to **SKYNET_4D**
6. Select **PROPERTIES** and then **BASIC**. Under the **TRAJECTORY TAB**, enter the following parameters.

    a. Step Size: 10.0 seconds

    b. Launch Latitude: 28.5 degrees

    c. Launch Longitude: -81.0 degrees

    d. Launch Altitude: 0.30480 km

    e. Burnout Latitude: -1.0 degrees

    f. Burnout Longitude: -19.0 degrees

7. Select **APPLY,** then **OK.**
8. Toggle to the **2D** map and select **START**.

Watch **SKYNET_4D** Mission liftoff from CCAFS.

9. Run the scenario as often as needed. When complete select **PAUSE.** Close out according to the instructions in **STARTING AND USING SATELLITE TOOL KIT.** Do not save the file.

PROPOSED SOLUTION:

There is no 'solution' per se; this was more of a demonstration of launch considerations.