CIVIL AIR PATROL

INTRO TO SPACE

STK LESSON PLAN FOUR:

CONDUCTING SATELLITE OPERATIONS

PART II - STK SCENARIO

This portion of the lesson plan illustrates the space system concepts you have learned about in Part 1. To do this, you will run a self-guided scenario using STK VO software. The scenario, broken down into two parts, will help you visualize the space system described earlier. As you recall, the major concepts introduced in Part 1 were space system elements and access determination.

The instructions below are a step-by-step guide to help you load, view, and understand the scenarios.

SCENARIO ONE

Scenario one will help you visualize the components of a space system. These components include the ground segment, space segment and data link segment. Additionally, the scenario helps visualize the access times necessary to conduct operations.

To run the scenario, complete the following steps.

1. Load **SCENARIO\LESSON4\ACCESS**.

2. Select the **EARTH VIEW 1 MAP** and the **RESET** toggle.

- All components of the space system are represented. First, the ground segment consists of the Santiago ground station, the White Sands lab ground station and a simulated Maxwell, AFB ground station. Second, the space element consists of LEO and GEO mission satellites, and a relay satellite called Tactical Data Relay Satellite (TDRS). Finally, the data link segment is illustrated by a very thin solid lines from the spacecraft to the ground station. The line not only represents data being transferred, but also indicates when the opportunity for data exchange data to occur. Note the GEO satellite has a static line to the Santiago ground station. It indicates Santiago has continuous access to the GEO satellite. On the other hand, the LEO satellite is only visible to the ground station for a relatively short period of time.

3. Select **START**.

- Observe a few satellite passes. The animation represents access opportunities. When the LEO satellite, depicted in yellow, traces its ground track, it will come within range of the Montgomery ground station. As it comes within range, a thin yellow line between the site and satellite appears. This line represents when the Montgomery site can communicate directly with the satellite. As it passes out of range, the yellow line will disappear. At the same time, the LEO satellite is in range of the relay (TDRS) satellite. The TDRS satellite, in a geosynchronous earth orbit, is in constant view of the ground station Thus, when the LEO satellite is out of range of its ground station, the

ground station can still communicate with the satellite via the TDRS. The GEO satellite shows continuous access to Santiago ground station. It is depicted by a light blue, static line.

4. Select **PAUSE.**

- Calculating actual access times is a complex mathematical problem. However, STK can perform these calculations for you. The following steps take you through the access determination process for determining when the LEO satellite passes over the Montgomery AFB ground station.

5. Select the **STK WINDOW**.

6. Highlight **MONTGOMERY.**

7. Select **TOOLS** then **ACCESS** from draw down menu.

8. Highlight **LEO 2** and select **COMPUTE**.

9. Select **ACCESS** under reports.

- An access report screen appears. It indicates the satellite will be in view of the ground station 8 times. The screen also includes the times the satellite will enter and exit the ground station field of view. Remember these are the specific times that the satellite will pass over the Montgomery Ground Station. **SELECT** one of those times.

10. **CANCEL** out of report.

- It takes more than knowing when the access time occurs to conduct operations. The ground segment must know where to point its antenna to pickup the satellite. STK also performs this calculation.

11. Select **AER REPORT**.

- The AER report screen appears. It provides the azimuth, elevation and range of the satellite from the ground station.
- Determine the azimuth, elevation, and range that correlates to the time you selected in step 9.
- These last steps illustrate that the LEO satellite will pass over Montgomery at a specified time and specified direction.

12. **CANCEL** out of reports.

13. Close out the file by selecting the **X.**

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:

ALPHA, the International Space Station (ISS), is a low earth orbiting satellite at approximately 220 NM above the earth. Relative to other satellites, it can be viewed by a ground observer at night. Using STK, calculate the access time when ALPHA could be viewed over Montgomery, Alabama ground position for today's date. See SOLUTION, next page, for an example.

Then, following similar instructions, see if you can compute the access time for YOUR location. How would you do this???

PROPOSED SOLUTION:

STK easily performs these complex access calculations. To generate a report, load **scenario\lesson4\ALPHA Problem** and proceed with the following steps.

1. Select **STK window and highlight ALPHA_problem**. Select **PROPERTIES**, **BASIC**, and **TIME** period tab.

2. Enter today's date under Start time and Epoch time.

3. Enter the date five days from now under Stop time.

4. Select **APPLY** and **OK**.

5. Select **the VO map** and expand the window.

6. Select **RESET** if ALPHA's orbit is not visible.

7. Expand the globe so that the north and south poles touch the top and bottom of the screen respectively. Orient the globe so that the words "Montgomery AL" and ALPHA's orbit are in view.

8. Observe ALPHA's orbit.

9. Select **START.**

10. Select **PAUSE**.

11. Select **the STK window**.

12. Highlight **Montgomery_AL.**

13. From the pull down window select **TOOLS** then **ACCESS.**

14. **The Access for Facility-Montgomery_AL window** will appear.

15. Highlight the associated object (ALPHA) and select **COMPUTE.**

16. A ***** will appear when computations are complete.

17. Select **ACCESS** under reports.

- The report indicates when ALPHA will be overhead in Montgomery for the days specified. Select a time when it is dusk or at night. Remember to subtract 6 hours (standard central time) to convert UTCG to local time.

18. Cancel out of report and select **AER.**

- Select the time used in step 17. This is a very useful report! It not only shows you the duration of time you will be able to see ALPHA as it flies by, but also the Azimuth, Elevation, and Range!

- The Azimuth is the direction of the compass you need to look to find ALPHA. If it said 270 degrees, look due west. In this case, ALPHA would be traveling from west to east at the elevation indicated.

- Elevation indicates how far off the horizon to look. If it said 45 degrees, that would be half way up, 90 degrees would be directly over head! For each pass, the chart also indicates the MAX and MIN elevation.

- Range is just a nice to know thing, it indicates how far away ALPHA is, in kilometers, at the time indicated.

How would you find YOUR city??

Hint: Highlight **ALPHA_problem**, then go to **TOOLS**, then **City Database**.
Check **City Name**, then type in you city and select **Perform Search**
If your city comes up, highlight it and select **OK**.

What happened??

How would you now compute access for your city??

(Tools, then Access. Highlight Alpha and hit Compute.)
You can then obtain either a Access or AER report.

You can do this for any city in the entire country!

One thing you can do is predict when the Space Station will fly over your house, up to several weeks, even months in advance!

Set up a chart and list the times (needs to be at night!) and the azimuth (direction) to look, and the elevation off the horizon.

If its not cloudy, you can watch the space station fly over your house every single time!