IV...Sending Data from a Satellite Back to Ground

Introduction:

How does a satellite communicate with the Earth?
Some military "spy" satellites take pictures with actual film. The film canisters are ejected back to earth and caught mid-air by waiting aircraft. Scientific research and weather satellites send their information back to earth in long strings of numbers. These numbers provide information about the brightness of millions of image "pixels" taken by satellite-borne, electronic cameras. In order for satellites to truly "communicate" information has to be sucessfully transmitted and received without any errors. The received information must also be clearly understood. In this activity, students will have hands on experiences in the communication processes of satellites.

Objectives:

- Students will learn that satellites use a transmitter and receiver system of sending information.

- Students will learn that communication requires that information be transmitted, received and understood or it is not considered communication.

- Students will learn how a satellite communicates the information it has gathered.

Materials:

- Flashlight

- Mirror

- Appropriate grade level grids

- Appropriate list of coordinates
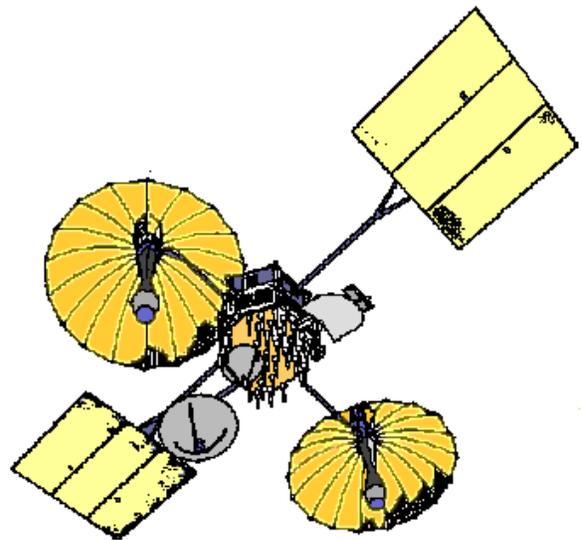
Procedure:

- Darken the room, and shine the flashlight at the mirror. Have the students observe the path of the light. A satellite "sends" its data by reflecting it off mirrors and directing it to the satellite dish on the earth's surface at a distant point.

- Students should play the "gossip" game, where a message is repeated from student to student. The student is the "transmitter" when saying the message to a classmate, and is the "receiver" when hearing the message from a classmate. Start with small groups of children and increase the group size. Discuss with the students the success or "noncommunication" of information as the groups get larger. While some students are being the transmitters, make some background noise. Compare this to satellite interference which leads to "noncommunication" of information.

- When a satellite is communicating it does not speak in words, but in numbers. These numbers correspond to a location on the grid system. In many instances, the transmission of these numbers is done three times, once from each of the cameras. Each set of numbers transmitted refers to a color filter. When the completed filters are place on top of each other, the true colors in the image are seen. Some of the activities below use this grid system to transmit information from one student to another. For some other satellite transmissions, the information at each location refers to the number of times the corresponding location was hit by charged particles. Some of the activities below use this type of grid system to transmit information to the students.

Grade K -6 warm-up activity (Graph #1)

- The students will be "read" a set of numbers that correspond to a square on the grid. If a number one is "read" for a square, then the students should color in the corresponding square. If a number zero is "read" for a square, then the students should leave the square alone. When complete the grid should display a message.

Grades K-2 (Graph #2)

- The students will be "read" a set of numbers that correspond to the location on the grid. One student reading the information to the other student can accomplish this, or the teacher can read it to the class. The square at that location will be colored in the corresponding color. The students will be read three lists. The areas that are colored in will model the way a satellite creates an image when it transmits data.

Grades 1-3 (Graph #3)

- The students will "read" a pair of coordinates for a location on the coordinate graph and the number of hits that correspond to that location. The students will use the range of hits chart to color the square its corresponding color. After all the coordinants have been completed, the colors will form an image as a satellite does when it transmits data.

- To prepare for this activity, make enough transparencies of graphs #4 - 7 for each student to have one. The students should work in groups of four for each of the graphs. Each student will be assigned a color for the graph that they are working on, and will "read" a pair of coordinates for a location on the coordinate graph and the number of hits that correspond to that location. Please note that the coordinate graph for these students is a 10 x 10 grid. The students will use the range of hits chart to color the corresponding squares for the assigned color. After all the coordinates have been completed, the four students should place their transparencies on top of each other so that the colors will form an image as a satellite does when it transmits data. When all students are finished, they will see that the four groups' grids will be put together at the end of the activity to form a large image. (Each of the four graphs will have four transparencies in a pile to show the layers of data that go into producing a single image.)

- The students will be comparing the completed four panel image with actual data from the IMAGE satellite's FUV instrument. This image may be found at http://image.gsfc.nasa.gov/poetry, find the link for live data for the most recent information.

Conclusions:

The students will learn how a satellite communicates information to the earth. Students will gain experience in two ways that data is transmitted, received and understood. The students will use "color" filters, and information based on the number of hits a location received to produce an image that models the way information, as images, is sent from a satellite

Extensions:

Grades 1 to 3 Students should draw a set of pictures with captions to show the sequence of data transmission from a satellite. They could make it in a sequence frame format or in story format.

Grades 4 to 6 Students should develop their "own" pictures to be transmitted via their classmates. They should write the coordinates keeping in mind that the three primary colors could be mixed to form other colors. They could then make a sequence frame to show the steps involved in satellite transmission.

Culminating Activity for Satellites:

Working in cooperative groups the students will complete a "life cycle" of a satellite in mural form. For the older students who designed a research satellite, the cycle begins with the decision process. For the younger students, the cycle begins with the launch of the satellite on the rocket. Each group's mural should include pictures and captions of how a satellite gets into and remains in orbit, and how a satellite communicates information. Students can use a long roll of paper or smaller papers attached together.

Graph #1 - Warm-up activity coordinates

If a "0" is transmitted, leave the square blank
If a "1" is transmitted, color in the square

#1	1	#11	1	#21	1
#2	0	#12	1	#22	0
#3	1	#13	1	#23	1
#4	0	#14	0	#24	0
#5	1	#15	1	#25	1
#6	1	#16	1		
#7	0	#17	0		
#8	1	#18	1		
#9	0	#19	0		
#10	1	#20	1		

Graph #1

21	22	23	24	25
16	17	18	19	20
11	12	13	14	15
6	7	8	9	10
1	2	3	4	5

Graph # 2 Coordinates and Color Bar Table

(Please note that each square could be colored more that one color.)

Yellow: 1, 5, 7, 8, 9, 12, 14, 16, 17, 18, 19, 20, 21, 23, and 25
Red: 2, 3, 4, 6, 10, 11, 13, and 15
Blue: 2, 3, 4, 6, 10, 11, 15, 22, and 24

Graph 2

21	22	23	24	25
16	17	18	19	20
11	12	13	14	15
6	7	8	9	10
1	2	3	4	5

Graph # 3 Coordinates and Color Bar Table

Location	# Hits	Location	# Hits	Location	# Hits
(1, 1)	23	(1, 3)	37	(1, 5)	25
(2, 1)	38	(2, 3)	7	(2, 5)	34
(3, 1)	32	(3, 3)	17	(3, 5)	38
(4, 1)	30	(4, 3)	2	(4, 5)	30
(5, 1)	25	(5, 3)	31	(5, 5)	21
(1, 2)	39	(1, 4)	36		
(2, 2)	26	(2, 4)	22		
(3, 2)	5	(3, 4)	4		
(4, 2)	28	(4, 4)	27		
(5, 2)	37	(5, 4)	39		

Number of Hits/Color Chart

#Hits	Color
0-9	Blue
10-19	Green
20-29	Yellow
30-39	Red

Graph # 3

Graph #4, Coordinates and Color Bar Tables

Location	Hits	Location	Hits	Location	Hits	Location	Hits
(1, 1)	3	(6, 3)	19	(1, 6)	19	(6, 8)	29
(2, 1)	15	(7, 3)	15	(2, 6)	17	(7, 8)	11
(3, 1)	23	(8, 3)	11	(3, 6)	22	(8, 8)	19
(4, 1)	39	(9, 3)	19	(4, 6)	39	(9, 8)	22
(5, 1)	36	(10, 3)	17	(5, 6)	12	(10, 8)	29
(6, 1)	24	(1, 4)	17	(6, 6)	29	(1, 9)	10
(7, 1)	16	(2, 4)	14	(7, 6)	14	(2, 9)	10
(8, 1)	9	(3, 4)	28	(8, 6)	18	(3, 9)	13
(9, 1)	5	(4, 4)	29	(9, 6)	15	(4, 9)	18
(10, 1)	2	(5, 4)	12	(10, 6)	19	(5, 9)	19
(1, 2)	18	(6, 4)	21	(1, 7)	11	(6, 9)	22
(2, 2)	28	(7, 4)	12	(2, 7)	19	(7, 9)	29
(3, 2)	37	(8, 4)	19	(3, 7)	13	(8, 9)	27
(4, 2)	25	(9, 4)	18	(4, 7)	19	(9, 9)	25
(5, 2)	39	(10, 4)	15	(5, 7)	29	(10, 9)	28
(6, 2)	14	(1, 5)	14	(6, 7)	22	(1, 10)	10
(7, 2)	19	(2, 5)	19	(7, 7)	19	(2, 10)	10
(8, 2)	11	(3, 5)	25	(8, 7)	12	(3, 10)	10
(9, 2)	18	(4, 5)	39	(9, 7)	16	(4, 10)	12
(10, 2)	11	(5, 5)	15	(10, 7)	23	(5, 10)	15
(1, 3)	13	(6, 5)	27	(1, 8)	10	(6, 10)	18
(2, 3)	19	(7, 5)	14	(2, 8)	11	(7, 10)	29
(3, 3)	24	(8, 5)	9	(3, 8)	19	(8, 10)	26
(4, 3)	19	(9, 5)	19	(4, 8)	15	(9, 10)	16
(5, 3)	29	(10, 5)	11	(5, 8)	18	(10, 10)	29

Use this table to match the number of hits to a color so that you can create the image.

# Hits	Color
0-9	Blue
10-19	Green
20-29	Yellow
30-39	Red

Graph 4
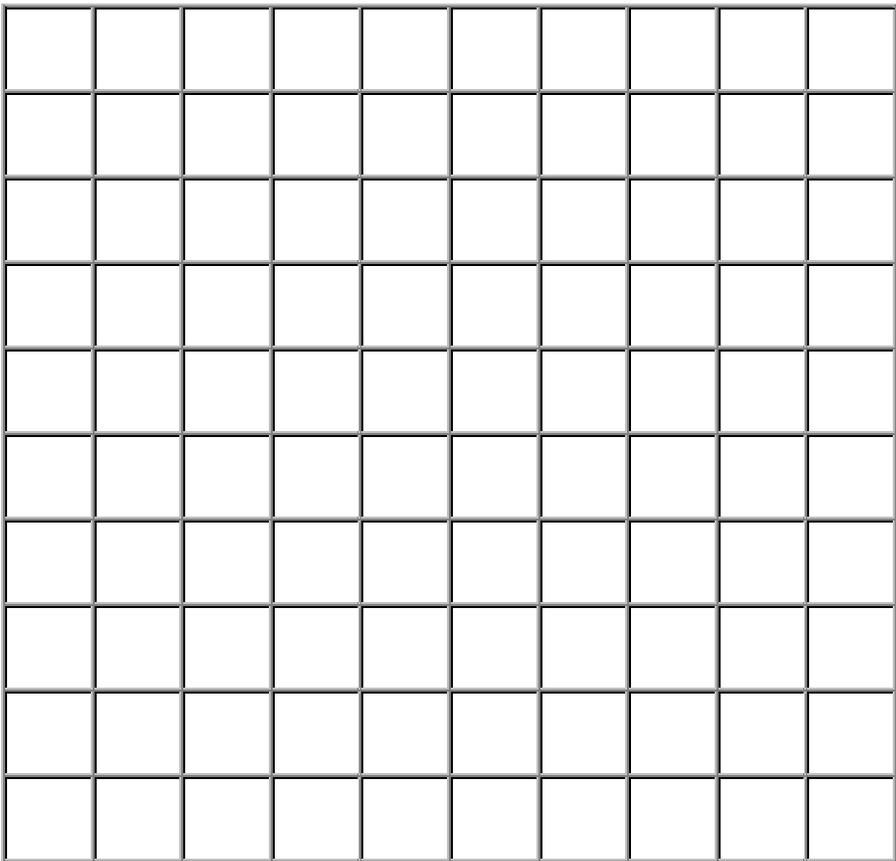
Graph 5: Coordinates and Color Table

Location	Hits	Location	Hits	Location	Hits	Location	Hits
(1, 1)	9	(6, 3)	17	(1, 6)	19	(6, 8)	33
(2, 1)	19	(7, 3)	14	(2, 6)	18	(7, 8)	28
(3, 1)	14	(8, 3)	28	(3, 6)	15	(8, 8)	22
(4, 1)	18	(9, 3)	37	(4, 6)	22	(9, 8)	24
(5, 1)	11	(10, 3)	11	(5, 6)	25	(10, 8)	26
(6, 1)	19	(1, 4)	19	(6, 6)	21	(1, 9)	29
(7, 1)	14	(2, 4)	12	(7, 6)	29	(2, 9)	27
(8, 1)	22	(3, 4)	15	(8, 6)	39	(3, 9)	34
(9, 1)	38	(4, 4)	17	(9, 6)	33	(4, 9)	36
(10, 1)	16	(5, 4)	14	(10, 6)	25	(5, 9)	22
(1, 2)	19	(6, 4)	11	(1, 7)	19	(6, 9)	28
(2, 2)	14	(7, 4)	19	(2, 7)	22	(7, 9)	24
(3, 2)	18	(8, 4)	25	(3, 7)	29	(8, 9)	25
(4, 2)	12	(9, 4)	39	(4, 7)	26	(9, 9)	27
(5, 2)	17	(10, 4)	28	(5, 7)	28	(10, 9)	29
(6, 2)	19	(1, 5)	11	(6, 7)	25	(1, 10)	29
(7, 2)	13	(2, 5)	19	(7, 7)	39	(2, 10)	21
(8, 2)	22	(3, 5)	17	(8, 7)	35	(3, 10)	26
(9, 2)	33	(4, 5)	15	(9, 7)	28	(4, 10)	28
(10, 2)	17	(5, 5)	13	(10, 7)	27	(5, 10)	29
(1, 3)	18	(6, 5)	14	(1, 8)	18	(6, 10)	24
(2, 3)	12	(7, 5)	29	(2, 8)	22	(7, 10)	27
(3, 3)	16	(8, 5)	38	(3, 8)	26	(8, 10)	28
(4, 3)	14	(9, 5)	33	(4, 8)	24	(9, 10)	23
(5, 3)	17	(10, 5)	29	(5, 8)	36	(10, 10)	22

Use this table to match the number of hits to a color so that you can create the image.

# Hits	Color
0-9	Blue
10-19	Green
20-29	Yellow
30-39	Red

Graph 5
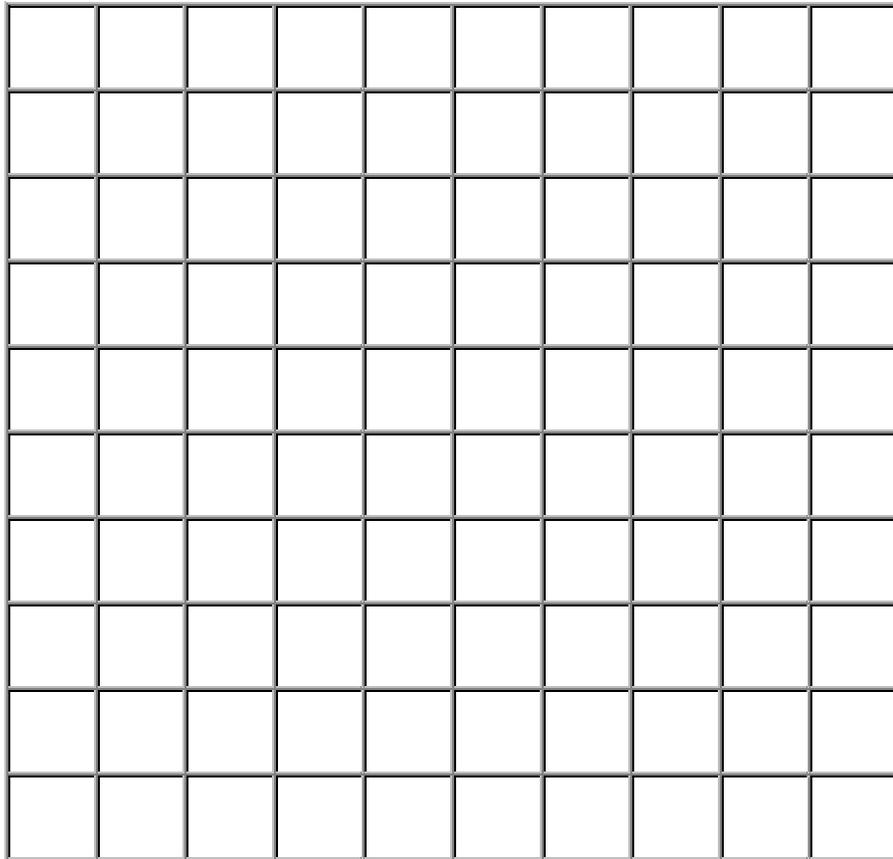
Graph 6: Coordinates and Color Table

Location	Hits	Location	Hits	Location	Hits	Location	Hits
(1, 1)	15	(6, 3)	29	(1, 6)	3	(6, 8)	25
(2, 1)	9	(7, 3)	17	(2, 6)	14	(7, 8)	18
(3, 1)	5	(8, 3)	14	(3, 6)	24	(8, 8)	4
(4, 1)	3	(9, 3)	16	(4, 6)	16	(9, 8)	9
(5, 1)	7	(10, 3)	15	(5, 6)	14	(10, 8)	3
(6, 1)	18	(1, 4)	9	(6, 6)	27	(1, 9)	7
(7, 1)	22	(2, 4)	4	(7, 6)	19	(2, 9)	17
(8, 1)	25	(3, 4)	8	(8, 6)	2	(3, 9)	26
(9, 1)	28	(4, 4)	11	(9, 6)	6	(4, 9)	24
(10, 1)	23	(5, 4)	21	(10, 6)	4	(5, 9)	28
(1, 2)	9	(6, 4)	28	(1, 7)	9	(6, 9)	25
(2, 2)	14	(7, 4)	25	(2, 7)	7	(7, 9)	19
(3, 2)	3	(8, 4)	19	(3, 7)	16	(8, 9)	4
(4, 2)	7	(9, 4)	17	(4, 7)	27	(9, 9)	7
(5, 2)	14	(10, 4)	11	(5, 7)	15	(10, 9)	3
(6, 2)	28	(1, 5)	3	(6, 7)	19	(1, 10)	9
(7, 2)	24	(2, 5)	6	(7, 7)	28	(2, 10)	18
(8, 2)	26	(3, 5)	18	(8, 7)	2	(3, 10)	26
(9, 2)	17	(4, 5)	25	(9, 7)	5	(4, 10)	31
(10, 2)	12	(5, 5)	19	(10, 7)	4	(5, 10)	27
(1, 3)	2	(6, 5)	28	(1, 8)	9	(6, 10)	18
(2, 3)	1	(7, 5)	18	(2, 8)	19	(7, 10)	8
(3, 3)	9	(8, 5)	9	(3, 8)	24	(8, 10)	3
(4, 3)	19	(9, 5)	11	(4, 8)	27	(9, 10)	9
(5, 3)	29	(10, 5)	19	(5, 8)	16	(10, 10)	2

Use this table to match the number of hits to a color so that you can create the image.

# Hits	Color
0-9	Blue
10-19	Green
20-29	Yellow
30-39	Red

Graph 6
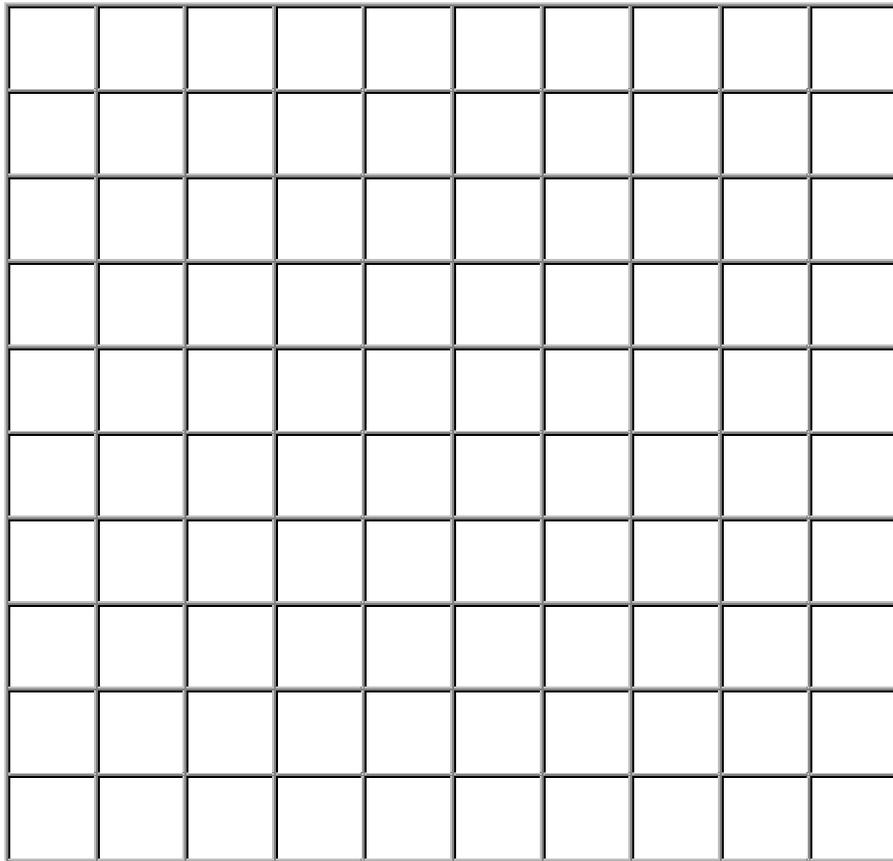
Graph 7: Coordinates and Color Table

Location	Hits	Location	Hits	Location	Hits	Location	Hits
(1, 1)	26	(6, 3)	22	(1, 6)	6	(6, 8)	11
(2, 1)	38	(7, 3)	11	(2, 6)	11	(7, 8)	15
(3, 1)	27	(8, 3)	8	(3, 6)	16	(8, 8)	27
(4, 1)	29	(9, 3)	6	(4, 6)	14	(9, 8)	31
(5, 1)	18	(10, 3)	9	(5, 6)	13	(10, 8)	19
(6, 1)	3	(1, 4)	12	(6, 6)	27	(1, 9)	5
(7, 1)	8	(2, 4)	15	(7, 6)	26	(2, 9)	7
(8, 1)	6	(3, 4)	22	(8, 6)	37	(3, 9)	9
(9, 1)	9	(4, 4)	28	(9, 6)	26	(4, 9)	6
(10, 1)	4	(5, 4)	26	(10, 6)	19	(5, 9)	8
(1, 2)	26	(6, 4)	34	(1, 7)	3	(6, 9)	18
(2, 2)	38	(7, 4)	28	(2, 7)	8	(7, 9)	16
(3, 2)	35	(8, 4)	15	(3, 7)	6	(8, 9)	26
(4, 2)	39	(9, 4)	3	(4, 7)	7	(9, 9)	36
(5, 2)	26	(10, 4)	8	(5, 7)	19	(10, 9)	19
(6, 2)	19	(1, 5)	11	(6, 7)	17	(1, 10)	8
(7, 2)	2	(2, 5)	16	(7, 7)	14	(2, 10)	6
(8, 2)	4	(3, 5)	14	(8, 7)	25	(3, 10)	2
(9, 2)	3	(4, 5)	16	(9, 7)	24	(4, 10)	7
(10, 2)	5	(5, 5)	22	(10, 7)	17	(5, 10)	4
(1, 3)	12	(6, 5)	27	(1, 8)	8	(6, 10)	18
(2, 3)	25	(7, 5)	37	(2, 8)	5	(7, 10)	15
(3, 3)	29	(8, 5)	26	(3, 8)	9	(8, 10)	24
(4, 3)	34	(9, 5)	16	(4, 8)	6	(9, 10)	31
(5, 3)	33	(10, 5)	8	(5, 8)	3	(10, 10)	19

Use this table to match the number of hits to a color so that you can create the image.

# Hits	Color
0-9	Blue
10-19	Green
20-29	Yellow
30-39	Red

Graph 7