Unit 6
Lesson #6.1
Repeater and Remote Operations

Prepared By Robert Lah, KD5HAW
Lesson Title Repeater & Satellite Operation

Curriculum Areas Science & Technology

Grades 6 – 8

Duration 2 class periods

Content Standards T – 1, T – 2, T – 4, SC – 4

Benchmarks T – 1.1, T – 2.1, T – 4.1, SC – 4.3

Goal

- Develop the students' understanding of practical communications applications.

Objectives

- Students will identify how wireless devices are used in practical situations
- Students will explain how repeaters extend the range of communication systems
- Students will discuss the role amateur satellites play in expanding the range of wireless communication in the world.

Instructional Content

How radio control devices work
How radio serves the community
Repeater use
Duplex vs. simplex
Amateur satellites
Remote Base Operations

Suggested Activities

1. Bring a radio-controlled car to class. Remove the body so the circuit board and mechanism is exposed. Observe how the radio signal causes the servos to operate.
2. See Activity Sheet #6.1 Repeater Anthology.
3. Field trip or classroom visit by a local communication expert to discuss how their communication system works: Law enforcement, fire department, emergency management, telephone company or Amateur Radio operator.
4. Write a report on different types of communication satellites:
    - What they do
    - How they operate

Unit 6 Activity Sheet #6.1
Repeater Analogy: Teacher's Guide

Robert Lah, KD5HAW

Introduction:

Various wireless services often use a mechanism called a **repeater** to assist in getting messages out. Repeaters are used by public safety organizations like police and fire departments, cellular phone companies, and amateur radio operators. Repeaters extend the **range** of two-way radios by taking incoming signals and re-transmitting them so that other radios that are beyond **line-of-sight** range can receive the signal and respond to them. Radios that operate at higher **frequencies** cannot easily get their signals to go around or through buildings, or over hills, or beyond the visible horizon. Unless two radios are directly in line with one another, it may be difficult to communicate. Here is where the repeater helps. The repeater is often located on top of a tall building, a high tower, or a nearby hill or mountain. It receives a signal from one radio on a certain frequency and sends it out on a different frequency so other radios can receive it. Because it is up high, it can send signals over much greater distances than would be possible on the ground between two individual radios. The higher elevation also helps to get the signals away from obstructions (such as buildings) on the ground. Here is a simple demonstration that will show you how a repeater can re-transmit a signal between two stations that are not directly lined up.

Problem:

Can you activate a television set by pointing the remote controller away from the set instead of right toward it?

Materials:

TV set with remote control; large mirror or glassed picture frame (clear plastic picture "glass" should work.) **Be careful handling glass. Ask your teacher to help you.**
(*The teacher may want to be in charge of handling glass mirrors or pictures in order to minimize the possibility of breakage and possible injury to students. If you use plastic picture glass, then the danger is reduced but remember that plastic sheet can also shatter if dropped and will make sharp edges.)*

Procedure:

1. Turn on the TV set by pointing the remote directly at the TV set and activating it. Shut off the TV set the same way.

2. Point the remote away from the TV and activate it. Does the TV turn on? Why or why not?
(Some controllers have a wide or somewhat omnidirectional pattern of operation. Prior to class, experiment with the controller to determine what the best angle is to insure that

the TV set will not turn on when the remote controller is not in line with the TV set. A 90 degree angle away from the TV seems to work best.)

3. Place a mirror or picture glass opposite the TV set where you were pointing the controller in step #2. Point the remote toward the reflector and try to "bounce" the signal toward the TV to turn it on. (It may take a little trial-and-error practice to do this. You will have to move the remote around a little to find the correct angle of reflection.)
(Position the mirror so that the glass is facing the TV in a direct line with the control beam pointing toward it at an effective reflective angle.)

4. Were you able to turn on the TV? If not, keep trying! *(Students may have to try awhile before they get it right.)*

Questions for Analysis:

1. Why must the TV set and the remote controller usually be in direct line-of-sight positions for the controller to turn on the television?
(Depending on the sensitivity of the controller and the receptor in the TV, the activating signal
will not work if the controller and TV are not properly aligned.)

2. Since the remote controller and the TV set were not directly facing each other, how were you able to turn on the TV set?
(The signal bounced off the mirror back toward the TV set.)

3. How did the mirror (or picture glass) extend the range of the remote control ?
(The controller is now able to activate the TV set from a different direction than usual.)

4. Imagine that our model resembles a public safety communications system. In our example, we need a police dispatcher, a mobile radio in a police squad car and a repeater to link the two stations. Consider the remote control, the TV set, and the mirror that we used in our demonstration. Which object resembles each of the stations in the public safety system?

(a) remote control *(Police dispatcher)*

(b) TV set *(Mobile radio in police squad car)*

(c) mirror *(Repeater)*

5. How is the infrared signal from the remote control like a radio wave?
(Both are part of the electromagnetic spectrum.)

6. How is the operation of the TV set an example of wireless control?

(You don’t need a cable between the remote control unit and the TV. The controller operates the TV by emitting an electromagnetic signal.)

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7. How is the operation of our model different from how a real repeater works? Give several examples.
(Expect a variety of responses. Repeaters connect radio stations over large distances; the TV and remote controller are in the same room. A repeater works omnidirectionally; a TV remote controller operates over a somewhat reduced angle. A repeater uses radio waves; a remote usually operates with infrared waves. A repeater uses two different input and output frequencies; a remote uses only one frequency, etc.)

8. Two amateur radio operators live 100 miles apart, on opposite sides of a tall mountain. Draw a diagram to show how the two operators can use a repeater to communicate with each other. In your diagram, label operator #1's location, operator #2's location, and the repeater's location. You may include symbols or drawings representing antennas, radio towers, radio waves, the repeater, houses, and the mountain.
(Students need to show the two stations separated by a high mountain. The repeater should be on top of the mountain. A radio wave – wavy line - should travel from one station toward the repeater. Another wave should travel from the repeater toward the other station. The repeater and the radio stations can be represented by antenna towers with vertical antennas on top. The repeater itself is usually housed inside of a building at the base of an antenna tower.)

Unit 6 Activity Sheet #6.1
Student Worksheet
Repeater Analogy

Robert Lah, KD5HAW

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_____

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2. Since the remote controller and the TV set were not directly facing each other, how were you able to turn on the TV set?

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3. How did the mirror (or picture glass) extend the range of the remote control ?

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(a) remote control_____

(b) TV set _____

(c) mirror _____

5. How is the infrared signal from the remote control like a radio wave?

_____

6. How is the operation of the TV set an example of wireless control? _____

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7. How is the operation of our model different from how a real repeater works? Give several examples.

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