



Minor Challenge Set #4

STEM Field: Electrical Engineering

Level: Intermediate

Challenge Name: Communications with Spacecraft

Materials required:

- Computer/laptop with internet access

Introduction:

In this activity, we will explore a new STEM discipline called telecommunications engineering, which involves using electrical and computer systems to enhance data communications. There is some overlap between electrical engineering and telecommunications engineering. For example, it is important to understand how electrical circuits and equipment work before we look at the operation of telecommunication networks.

When it comes to scientific telecommunication systems, it's hard to top NASA Deep Space Network. NASA has been sending robotic spacecraft into the solar system, which then send information and images back to Earth for further study and analysis. This is made possible by the Deep Space Network - a worldwide network of spacecraft communication facilities. These facilities are located in the United States (California), Australia (Canberra) and Spain (Madrid).

These huge dish-type antennas are especially designed to detect radio waves, and very faint ones too. As the signal travels to Earth, it continues to lose energy. So, signals arriving at the antennas on Earth

can be as weak as a billionth of a billionth of a watt — that is 20 billion times less than the power required for a digital wristwatch. In addition, the antennas must point very accurately towards the spacecraft, because an antenna can “see” only a tiny portion of the sky.

Through this project, we hope to understand the big picture of how data communication is enabled through these systems!

Instructions:

- 1) Navigate to <https://spaceplace.nasa.gov/dsn -game/en/>. It is recommended that you open this link on a browser such as Chrome.
- 2) In this game, you will be sending information to, and receiving information from NASA robotic explorers. Your goal is to “uplink” and “downlink” data with NASA spacecrafts and try not to lose any data coming down!

By the end of this game, you should take a screenshot of your result, which looks similar to the figure below.



- 3) Take note of 3-5 observations you made while playing this game. Examples can include the type of data information that was transmitted, where the antennas of the Deep Space Network are located, and any other pieces of information you found interesting!
- 4) Navigate to the following websites for more information about the Deep Space Network, and answer the questions in the Reflection Questions section. Afterwards, you can do your own research on any topics that you find fascinating.
 - How does NASA communicate with spacecraft? - <https://spaceplace.nasa.gov/dsn-antennas/en/>
 - [Speaking in Phases](#)
 - [Catching a Whisper from Space](#)

Reflection Questions:

- What improvements would you like to make to this challenge?
- What are the key concepts of science and engineering that relate to this challenge?

- What did you notice about the type of information that was transmitted? (Hint: this is the only language computers can understand and process).
- What do “uplink” and “downlink” mean?
- Why does the antenna dish have a parabolic shape?
- From your research and in your own words, can you explain how the antennas “hear” the spacecraft’s signal? What are some of the problems in this communication? What technologies are being used to minimise those problems?

Submission Guidelines:

- Submit a screenshot of your completed game and answers to the Reflection Questions.

Note: When submitting this Minor Challenge, please upload pictures of your project or experimental setup. Remember, if you want to upload pictures of your Minor Challenge that also include you, please check if it is OK with your mentor first.

- There is a submission form directly on the Minor Challenge page here: [https://sciencechallenge.org.au/index.php/minor - challenges/](https://sciencechallenge.org.au/index.php/minor-challenges/). Fill out the details and make sure you upload your submission

Learn More! Resources:

- What is the Deep Space Network - https://www.nasa.gov/directorates/heo/scan/services/networks/deep_space_network/about
- Deep Space Network Complexes - https://www.nasa.gov/directorates/heo/scan/services/networks/deep_space_network/complexes

Sources:

Nasa.gov. 2020. Capturing a Whisper from Space. [online] Available at: [Catching a Whisper from Space](#) [Accessed 14 June 2021].

Fisher, D., n.d. [online] Nasa.gov. Available at: [Speaking in Phases](#) [Accessed 14 June 2021].