SEEC 2016

Optical Communication Using an LED and a Solar Panel

Learning how communication with visible light works

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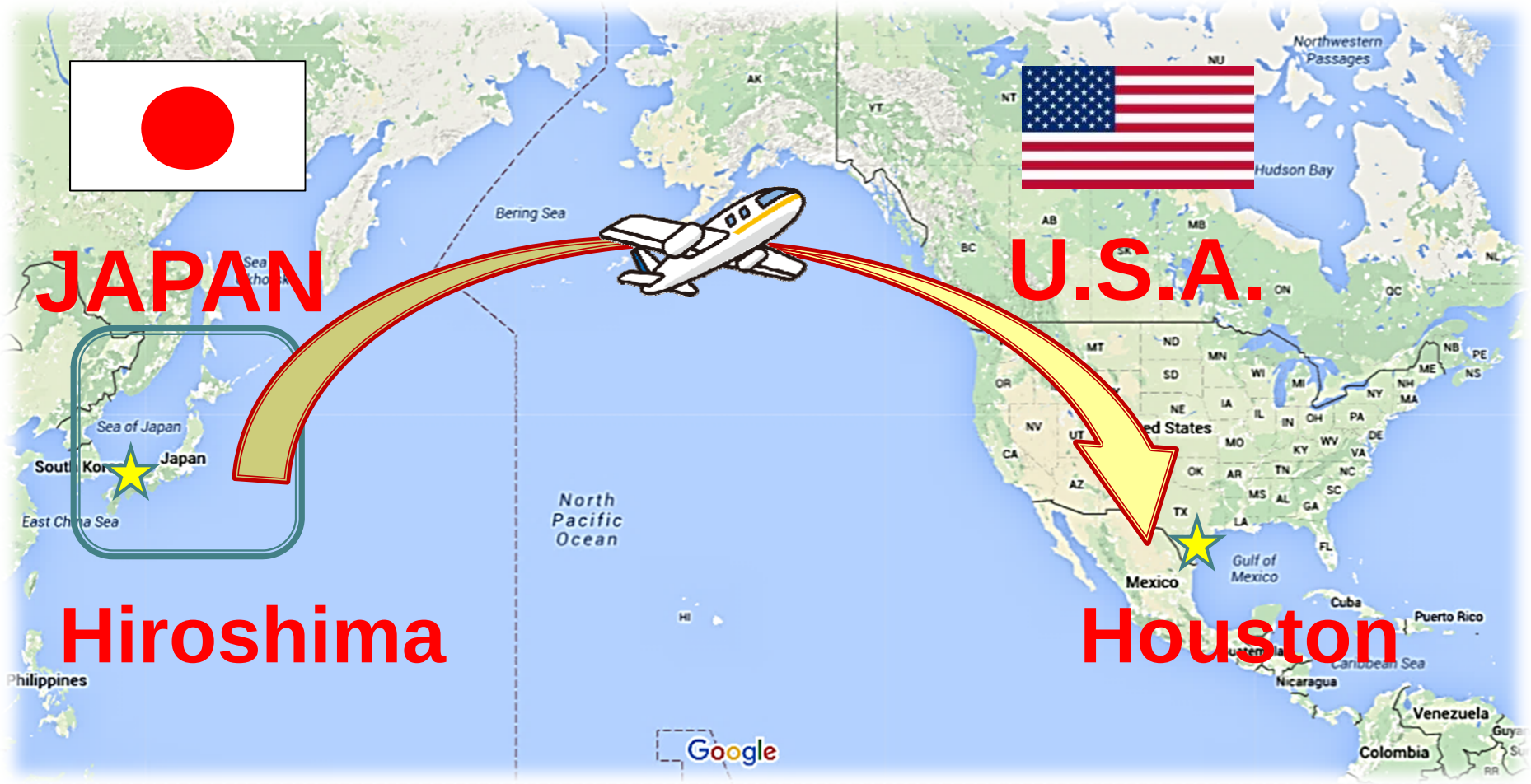
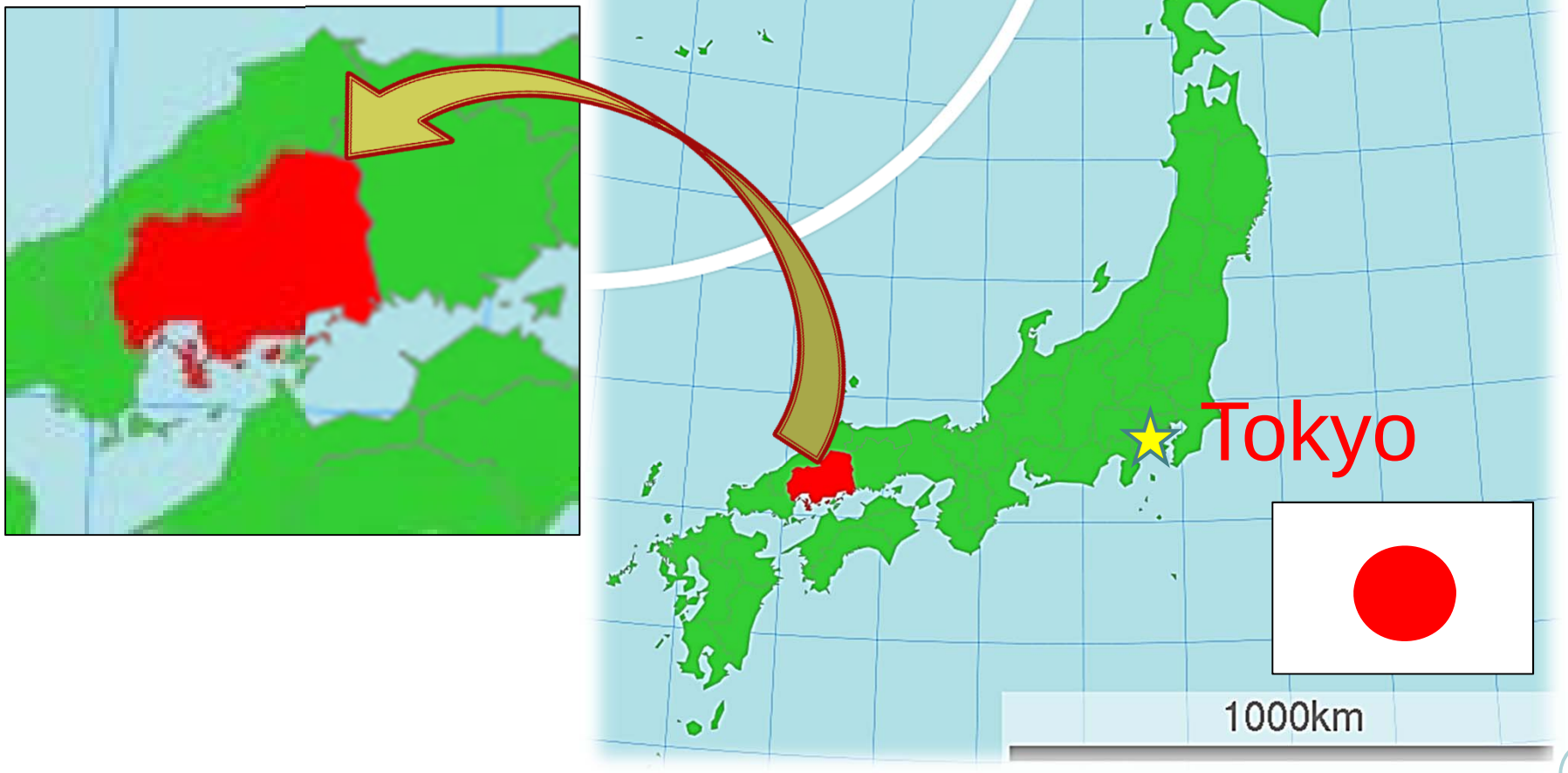
Japan & Houston



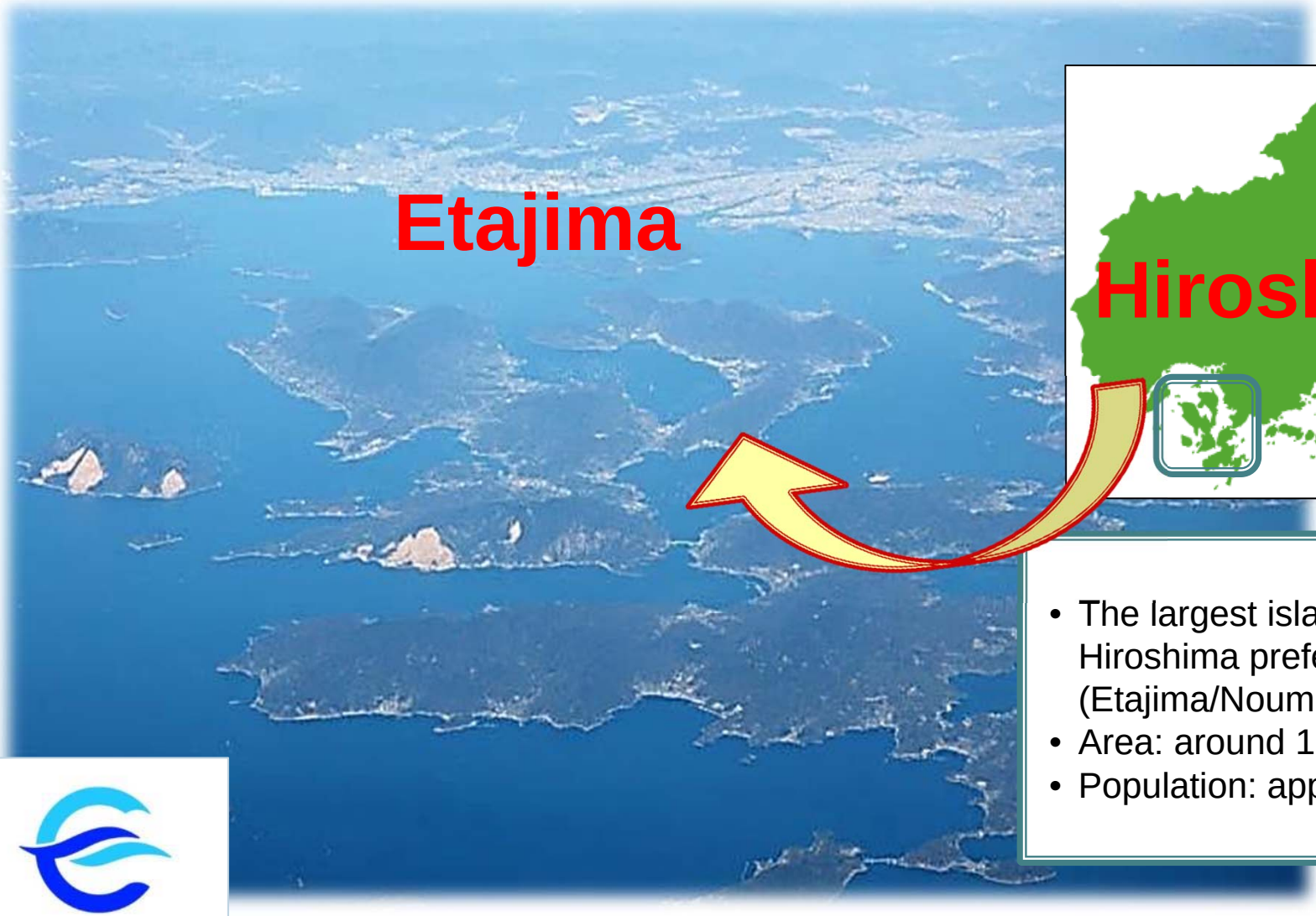
Hiroshima



World Heritage Sites in Hiroshima

Atomic Bomb Dome

Itsukushima Shrine



- The largest island in Hiroshima prefecture (Etajima/Noumishima)
- Area: around 101 km2
- Population: approx. 25,000

Etajima City

- Second largest producer of shelled oyster in Japan
- Oranges from Etajima city are sold around Japan as "Hiroshima Oranges"

Trivia Quiz

If you line up the shells of all the oysters eaten in Hiroshima, front to back, in one year, how far would they go?

① From Hiroshima to Houston

② Circle the world 1 time

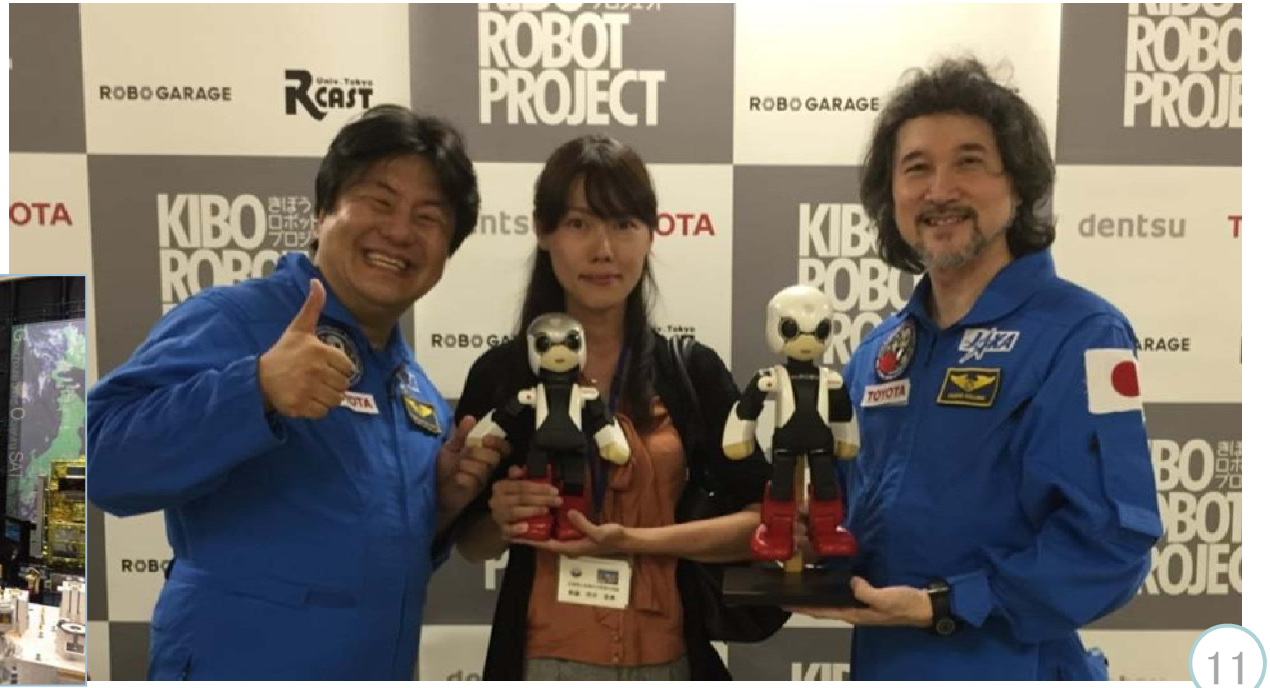
③ Circle the world 10 times

④ From the earth to the Moon

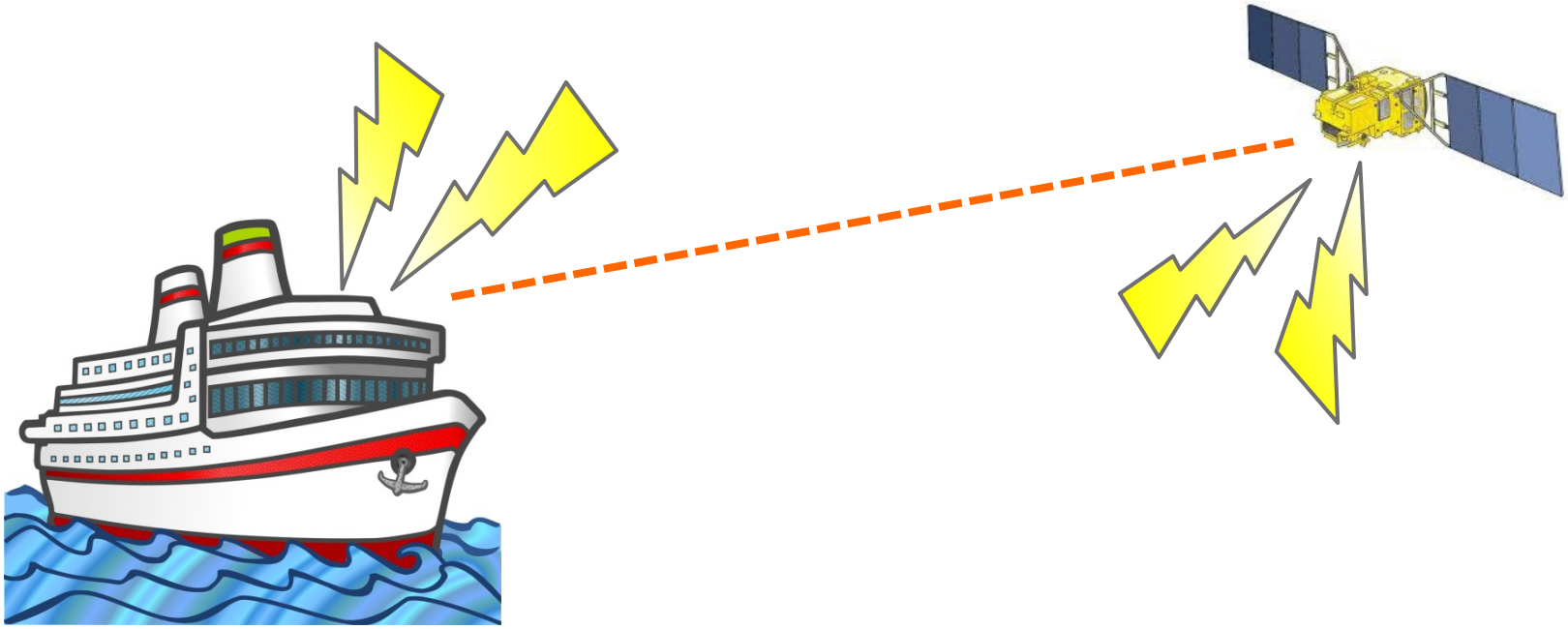
Noumi Junior High School, Etajima City

NO SCHOOL BELL!!

ISS
(the International Space Station)


ROBOGARAGE
ROBOT PROJECT
ROBOGARAGE
dentsu
TOYOTA

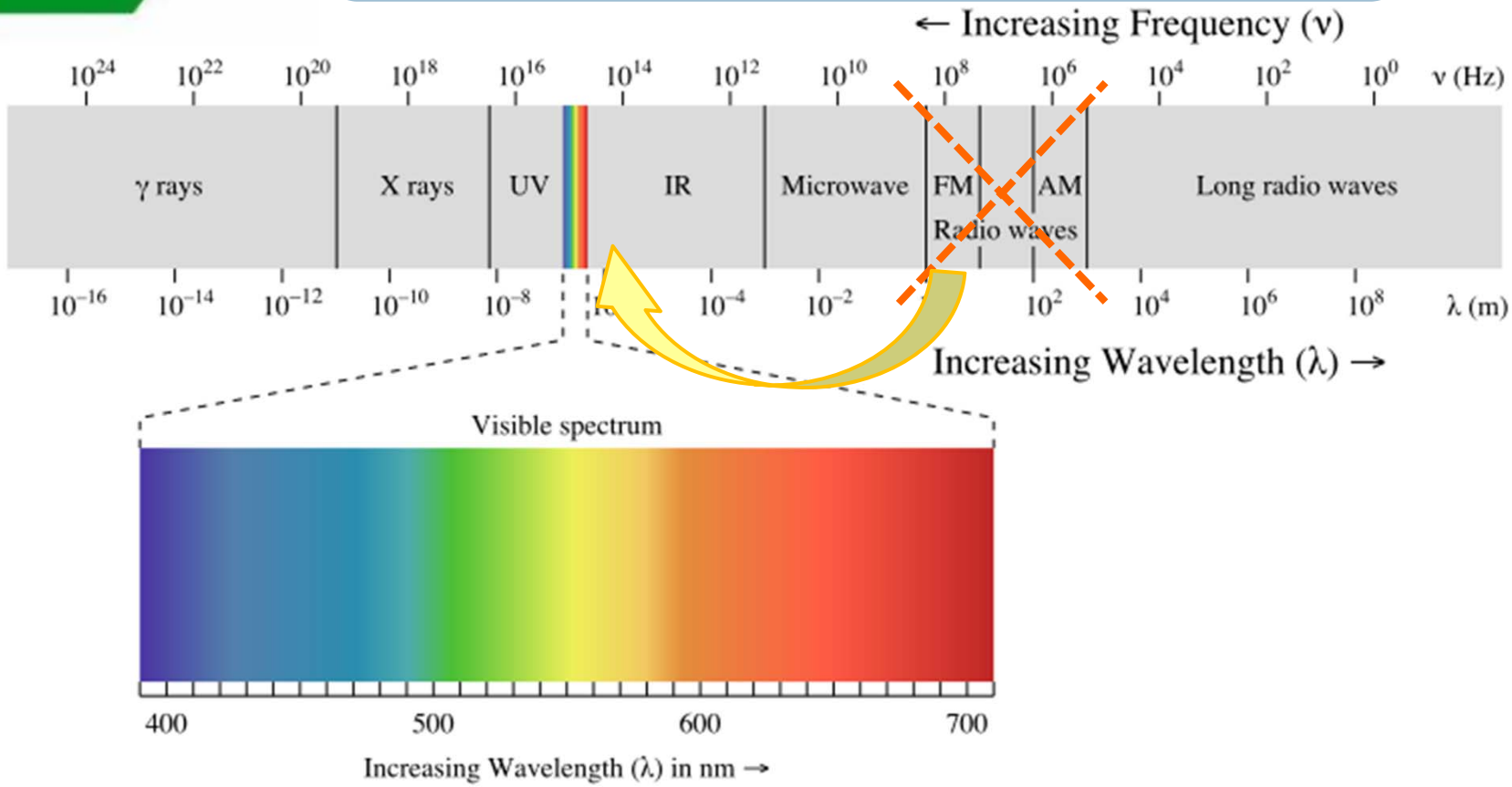
Don't ships get lost in the vast ocean??
How do ships know where they are??



-> They use GPS* to find out their location

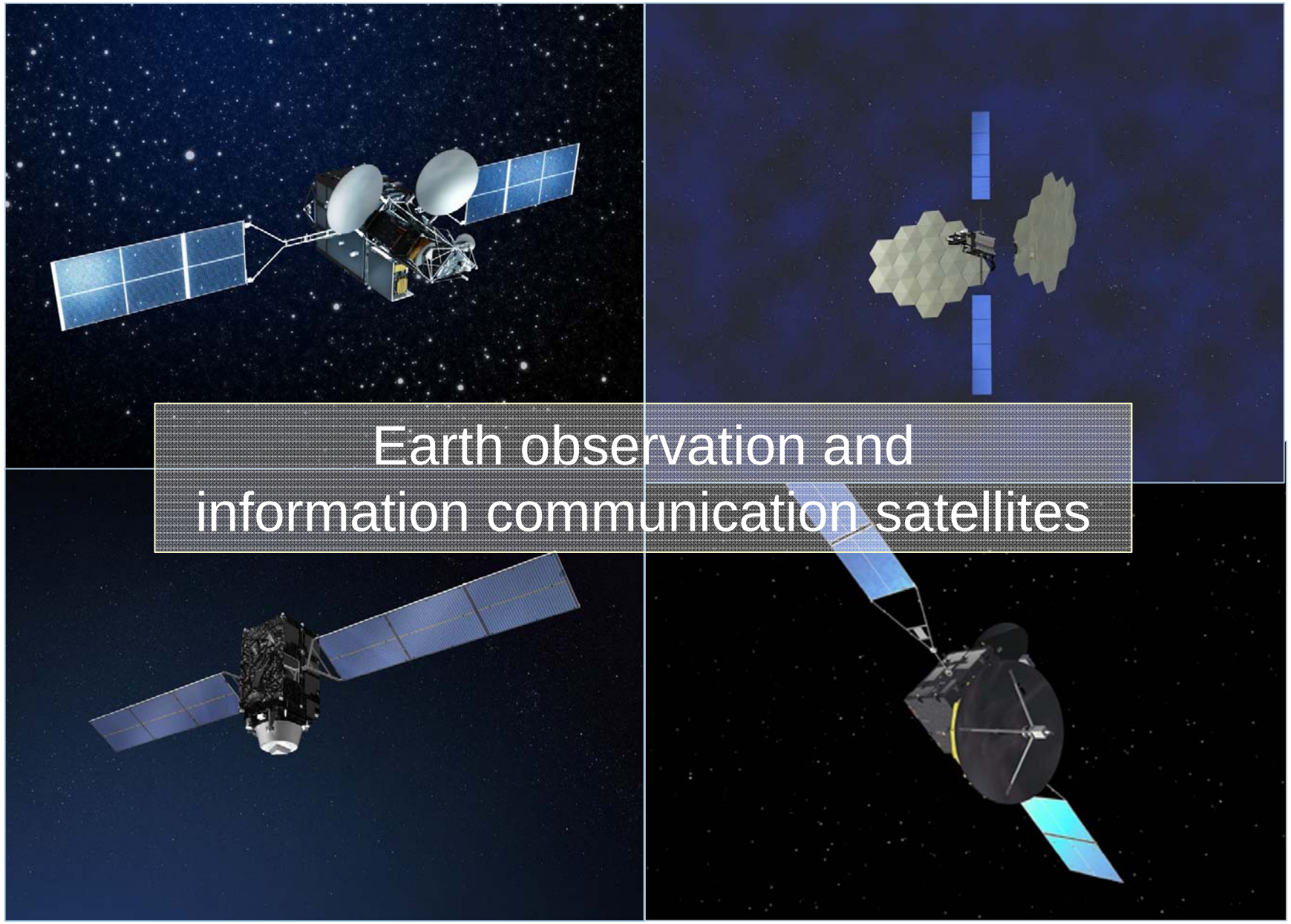
*Global Positioning System

I've never seen a radio wave!
Can you see a satellite communicating with your eyes??

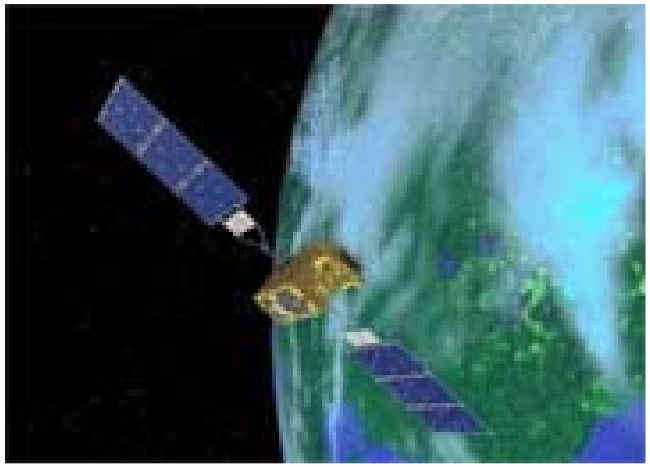


-> Communication you can see??

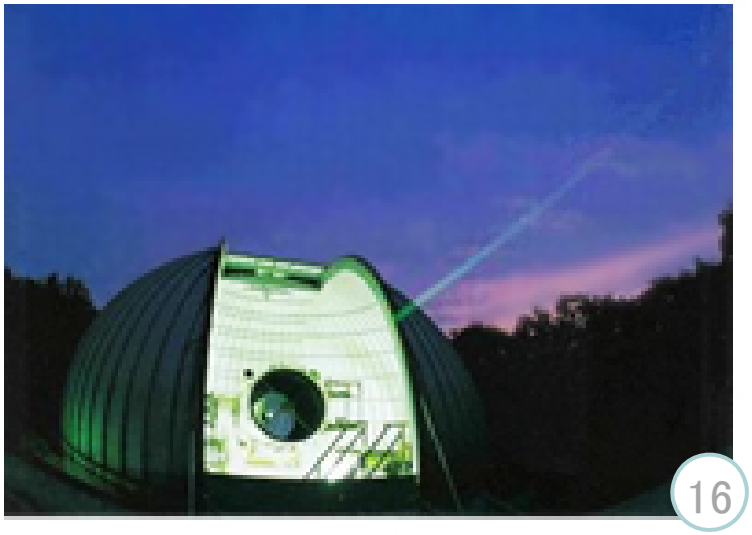
Satellites in Orbit Around the Earth



Test optical data relay satellite which succeeded in communicating with satellites and ground stations



What is Optical Communication??



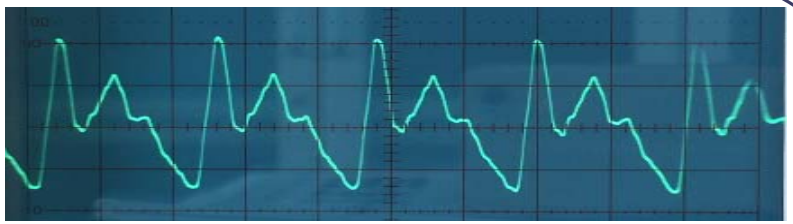
NICT
(optical communication ground station)

Transmitting Sound (1)

Vocal vibration → Air vibration

oscilloscope

a



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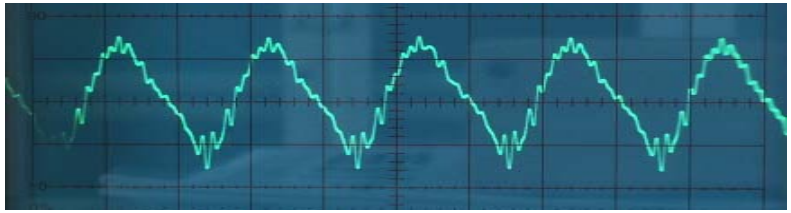

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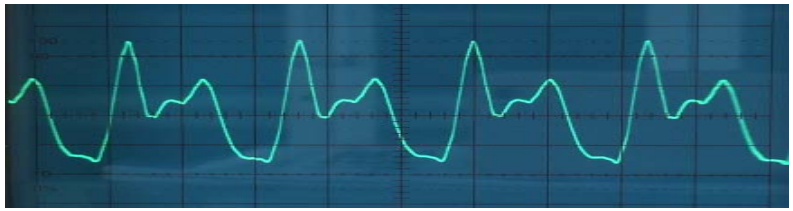

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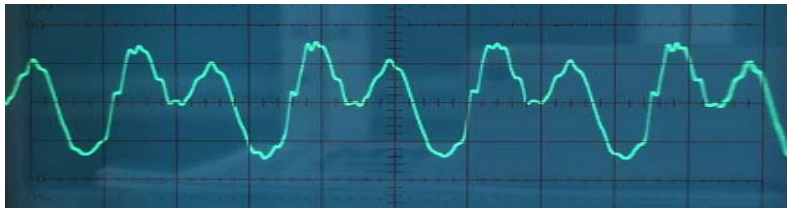

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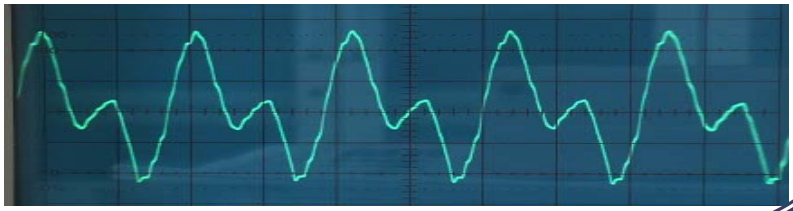


The volume and frequency of the sound differ depending on your voice

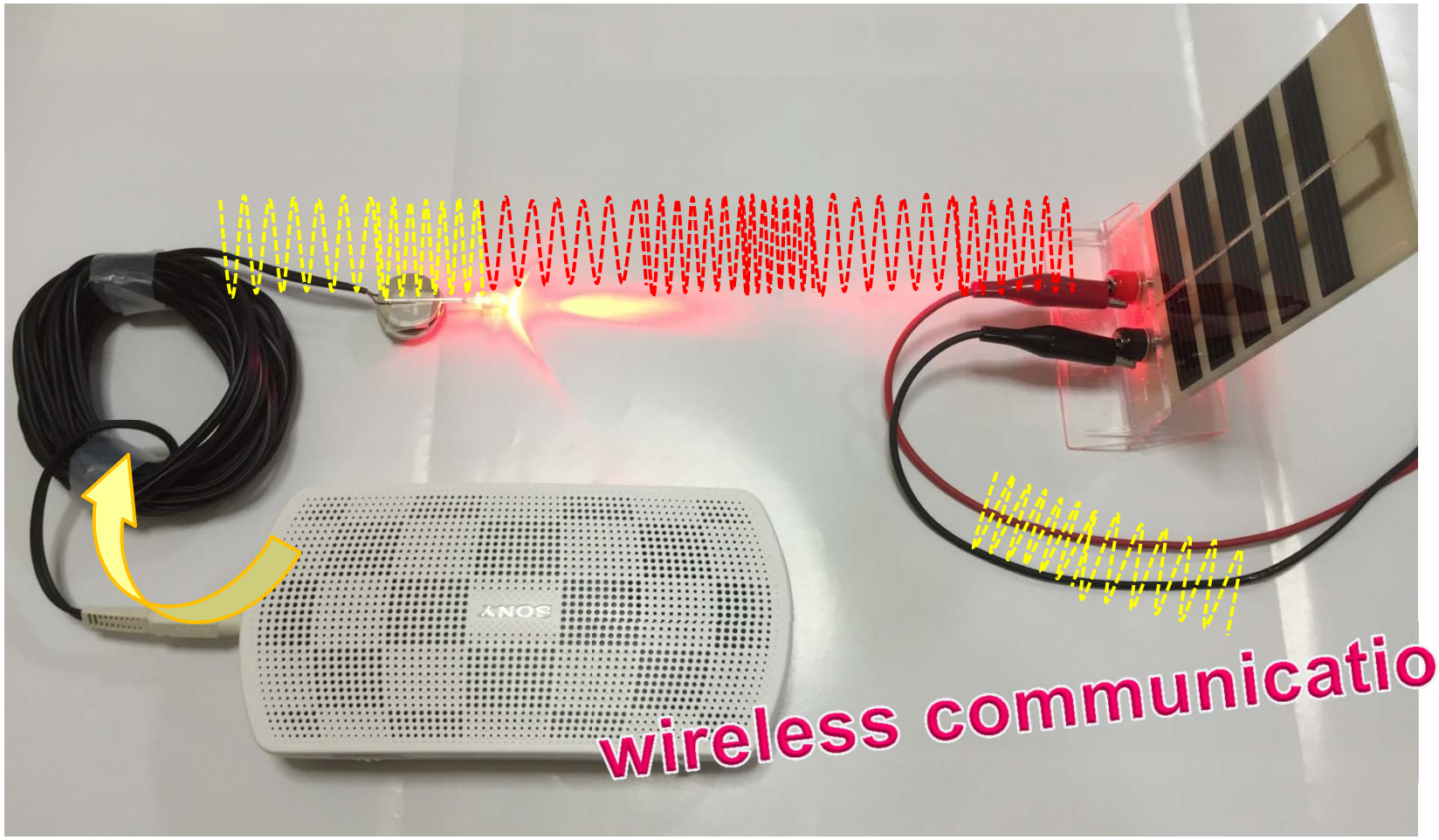
Transmitting Sound (2)

Vocal vibration → String vibration

Transmitting Sound (3)

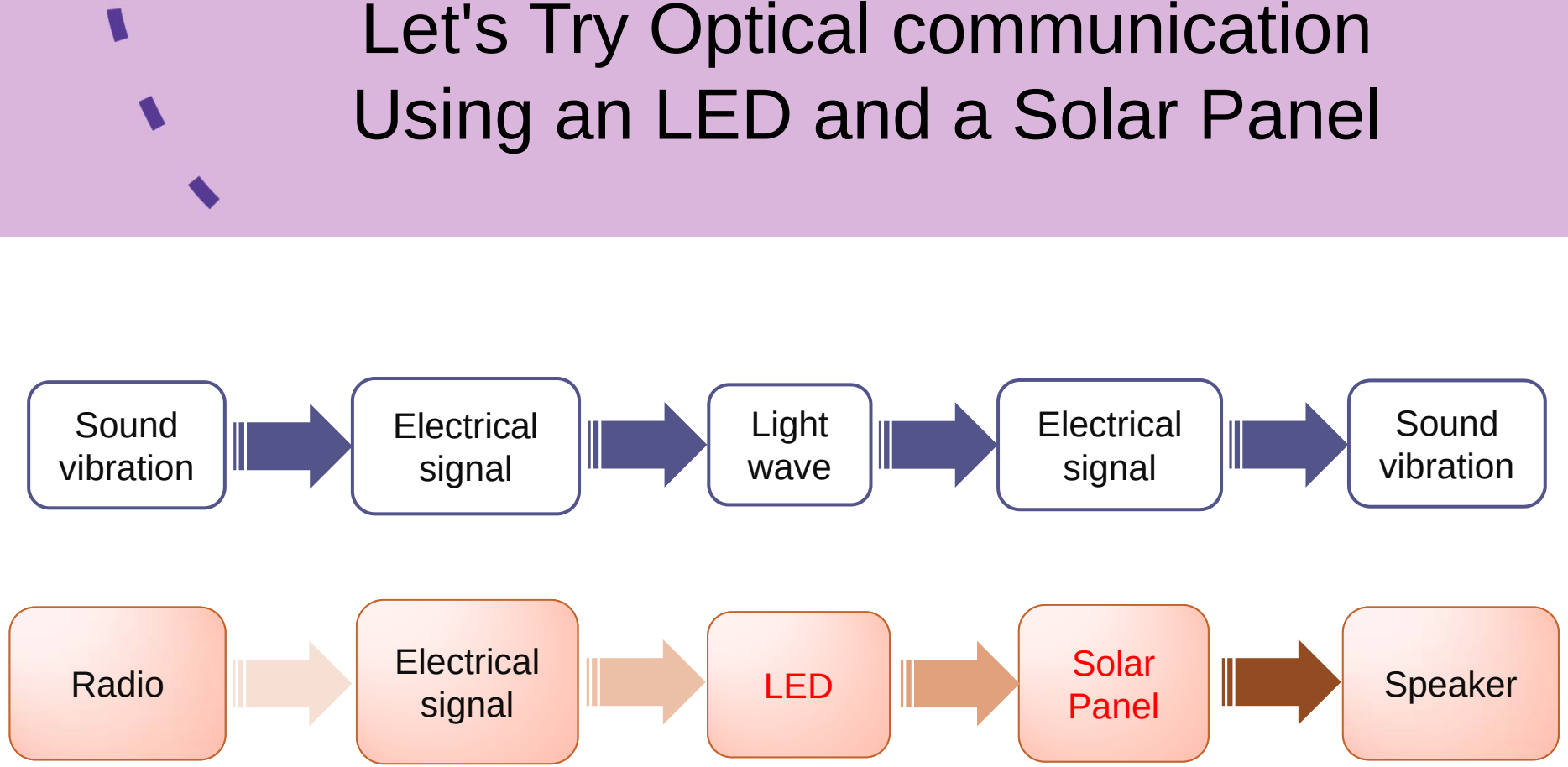
Vocal vibration → Electrical signal → Sound vibration

Transmitting Sound (4)



Sound vibration → Electrical signal → Light wave → Electrical signal → Sound vibration

Let's Try Optical communication Using an LED and a Solar Panel

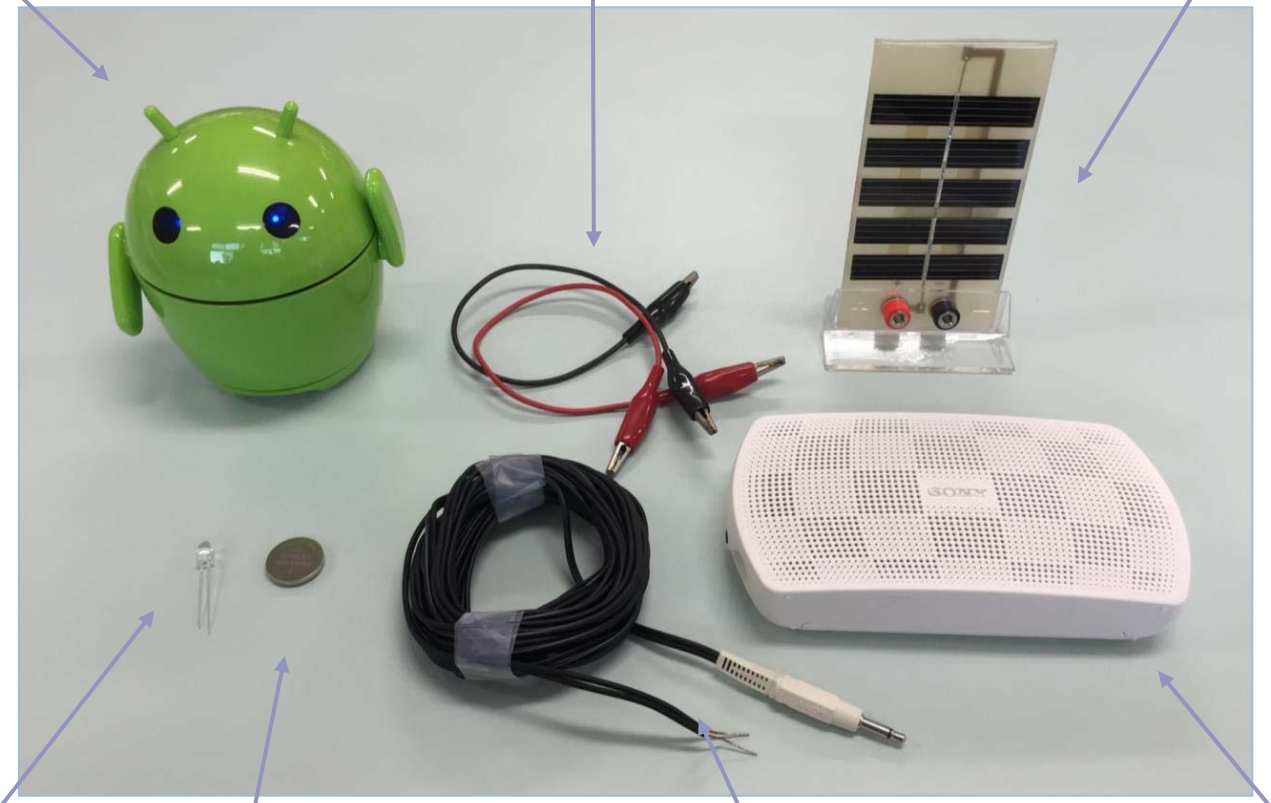


Things to prepare

(1) Speaker

(2) Electrical clips

(3) Solar panel



(4) LED

(5) Button battery

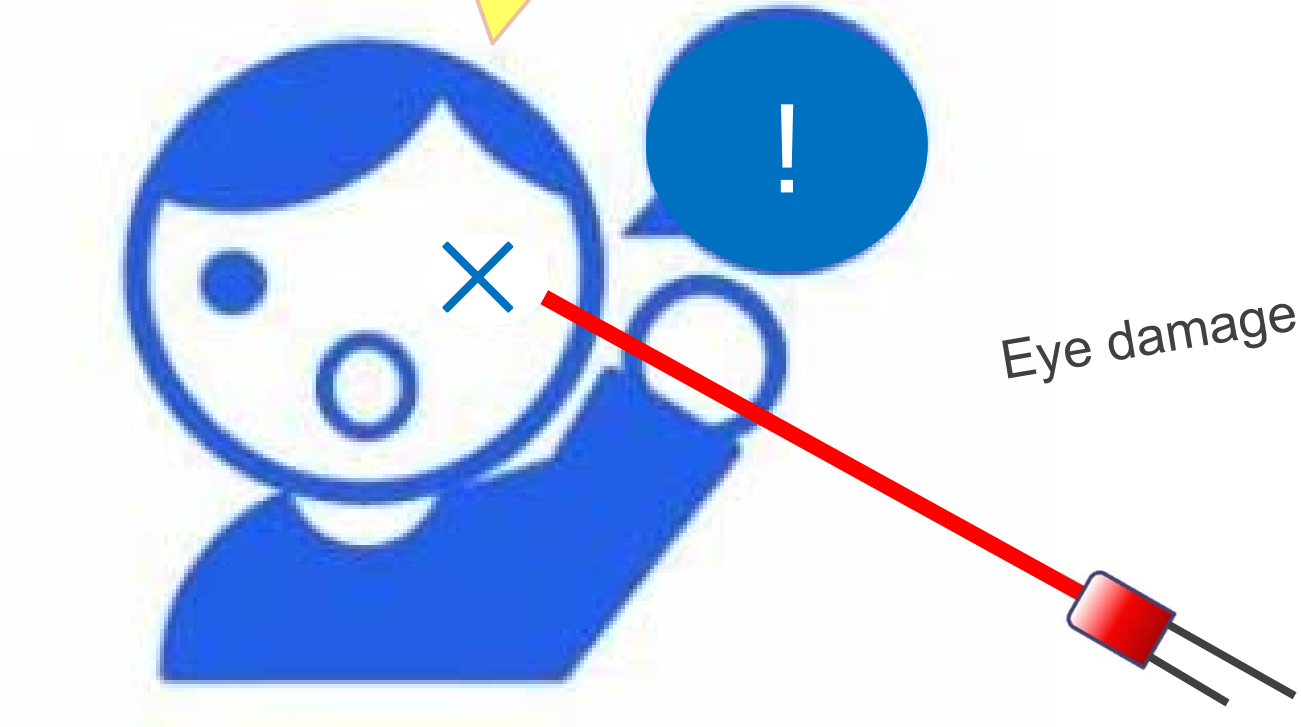
(6) Speaker cord

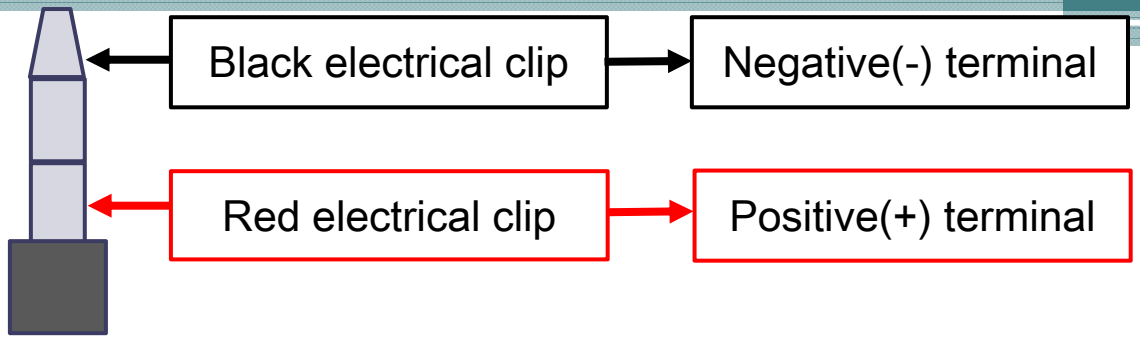
(7) Radio

Caution!

Don't look straight at the LED light

Don't shine the LED light on anyone's face





Light receiver

- Connect two electrical clips to the pin plug on the speaker
- Connect the ends of the electrical clip to the positive and negative terminals of the solar panel

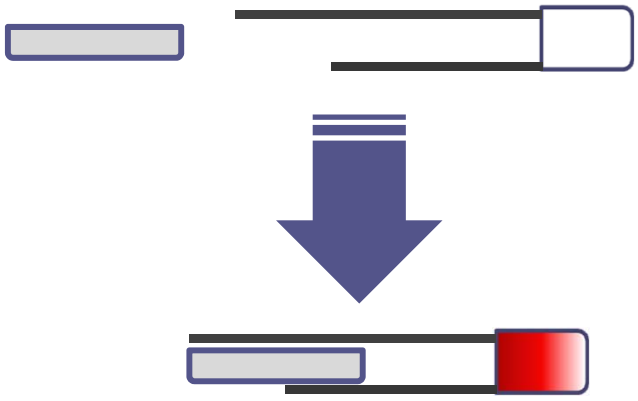
Tuning

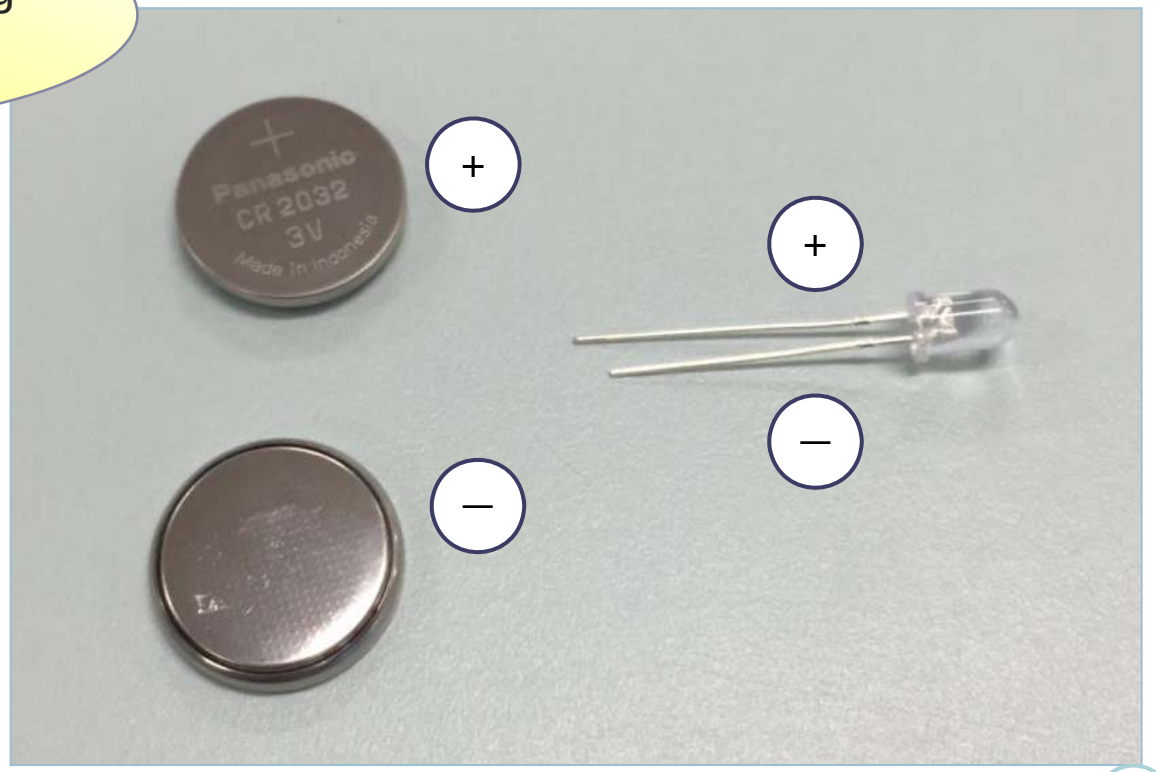
ON

Earphone jack

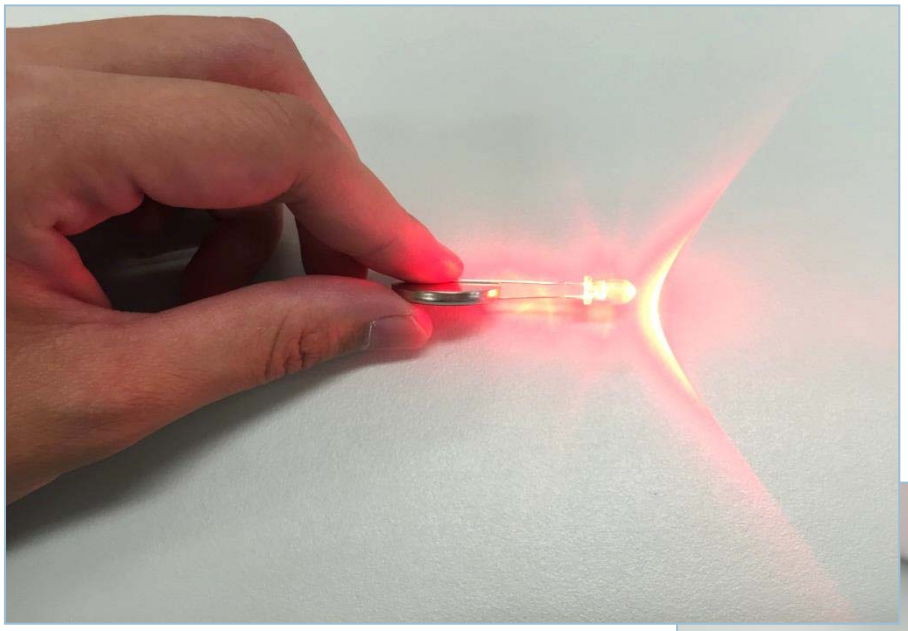
Light transmitter

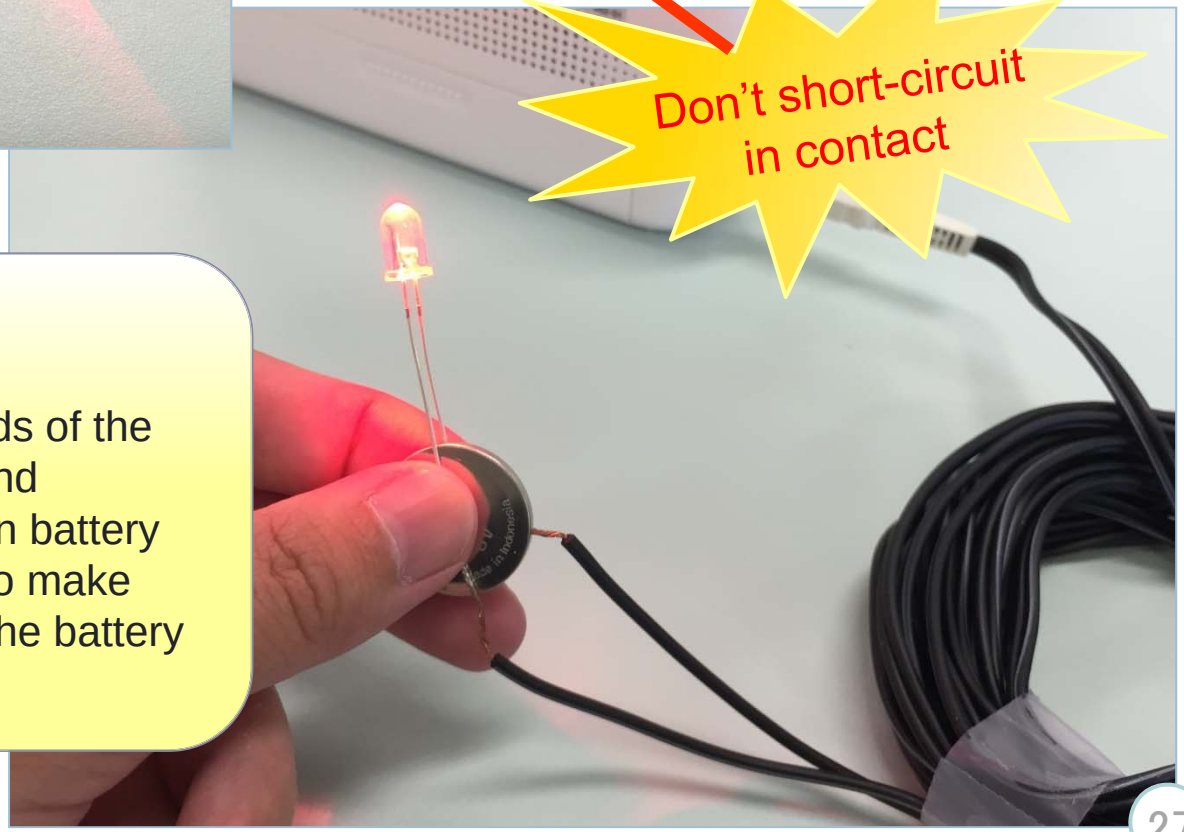
Connect after turning on the radio



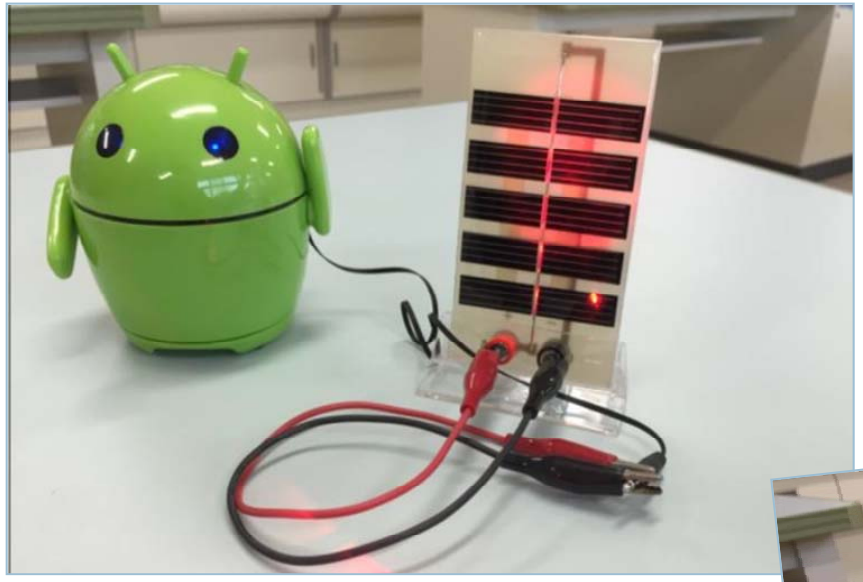


Light transmitter

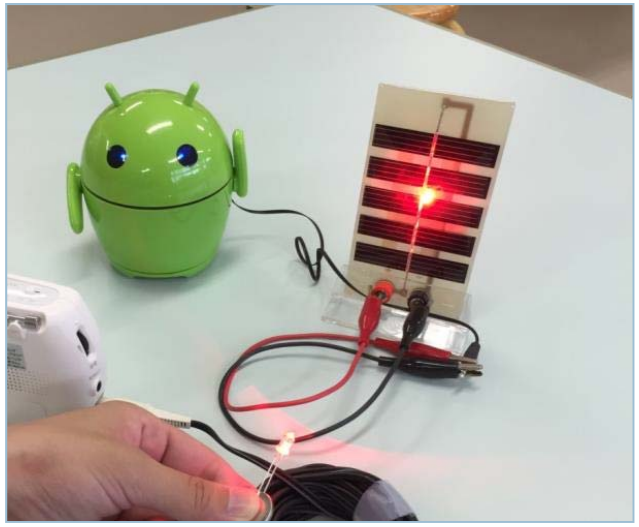


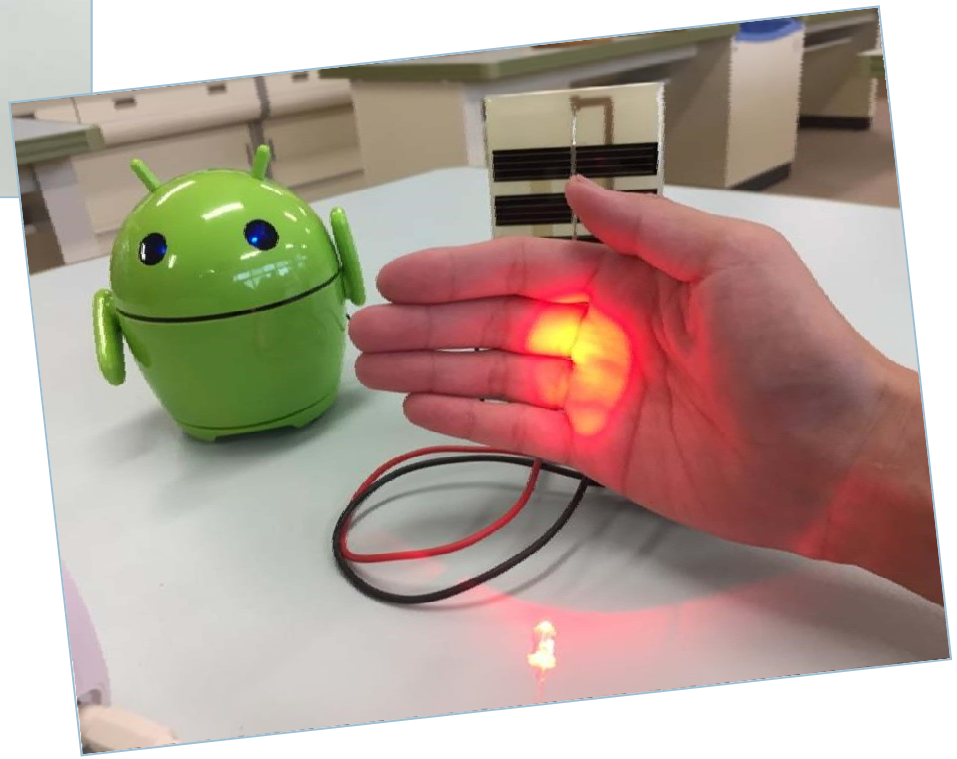


- Turn on the LED
- With the LED on, place the ends of the speaker cord on the positive and negative terminals of the button battery
- Hold the LED and cord firmly to make sure they stay in contact with the battery



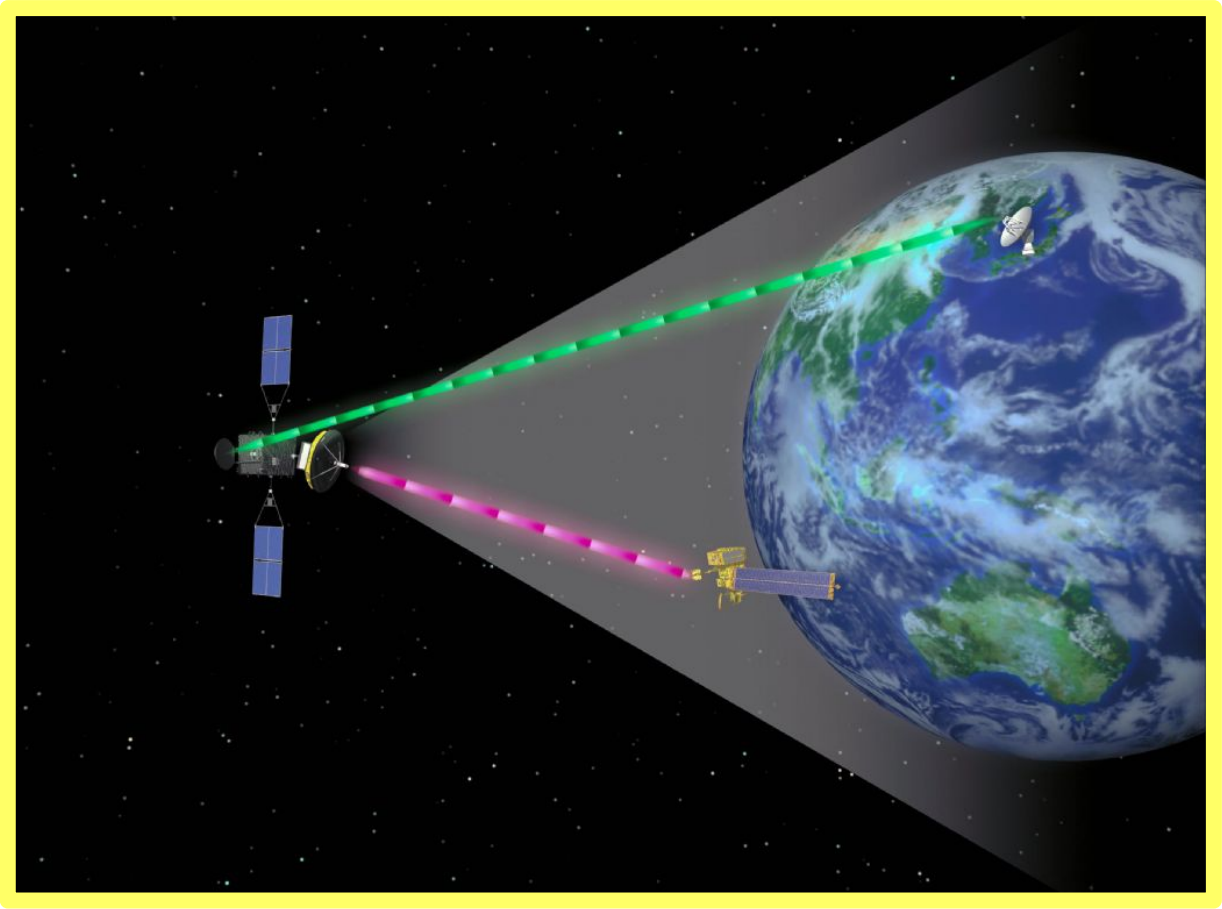
Let's play♫

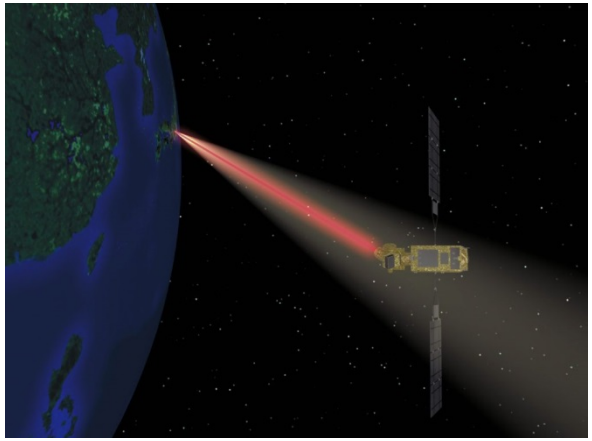


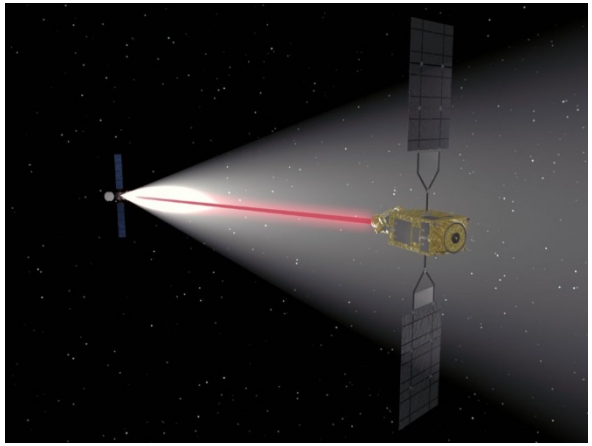


① Let's try blocking the LED light with our hands.
② Let's being the LED closer to the solar battery, then move it farther away until you can no larges hear the radio.

The Future of Optical Communication





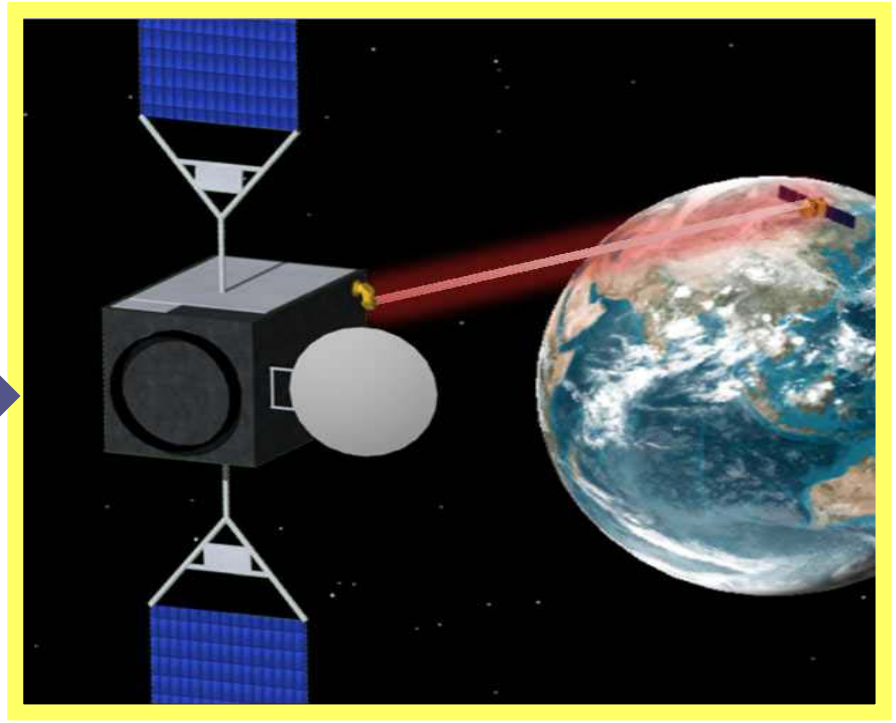


Use in optical data relay satellites

The Future of Optical Communication

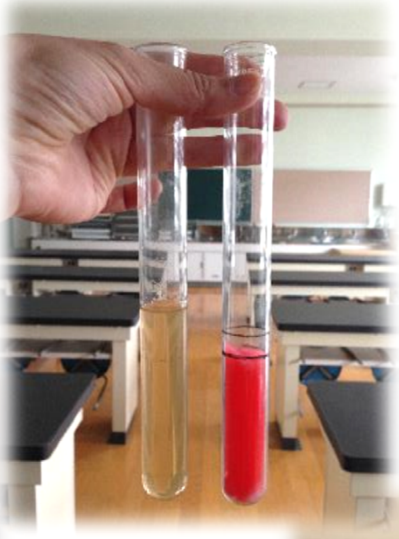
DRTS(KODAMA):
Relay technology satellite
Communication speed: **240Mbps**

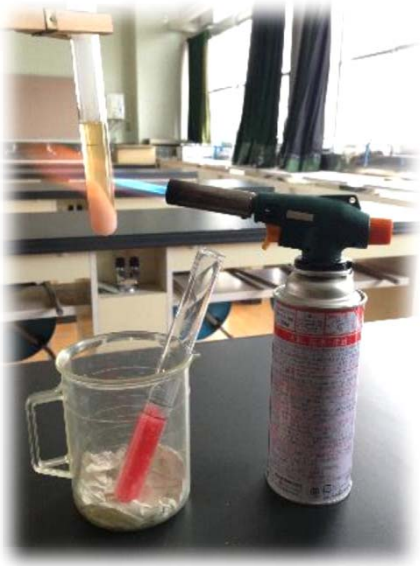
OICETS(KIRARI):
Experimental satellite for optical communication between satellites



Optical data communication satellites
Communication speed: **1.8Gbps**

Conclusion





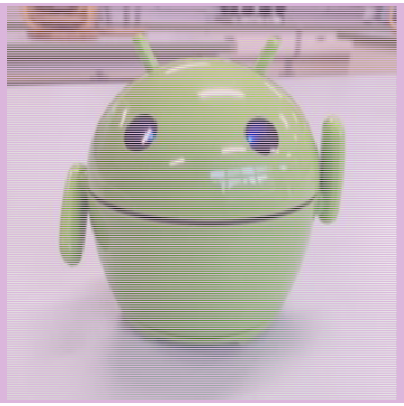
Present

Red, Green, Blue color of LED

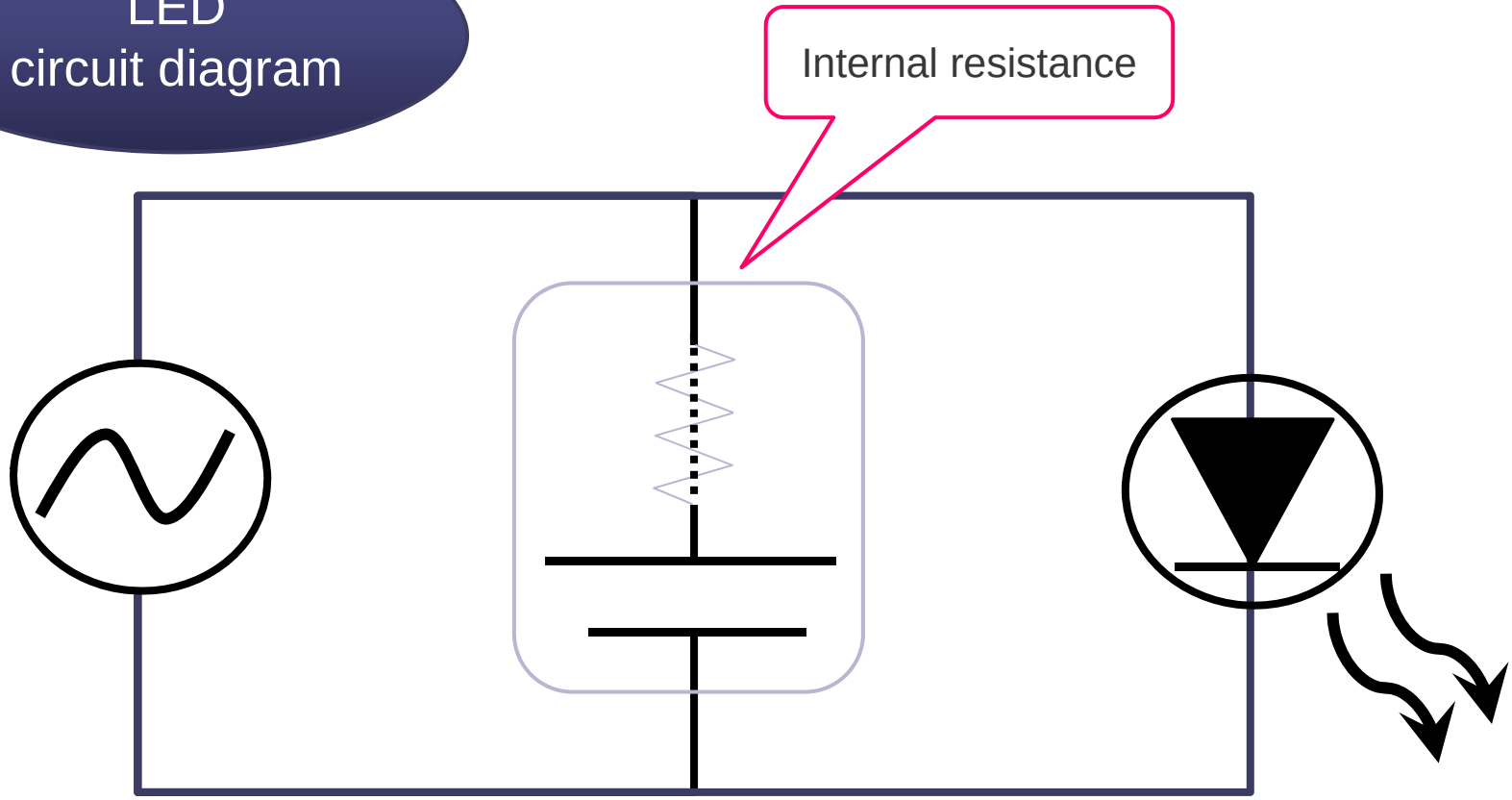
&

Button buttery

Thank You !!



LED
circuit diagram



*Connecting the battery directly to the plug could possibly trip the LED, so please be careful.
Here, as we are performing an experiment we connected it directly without using a resistor or capacitor in order to make things easier.

Script (SATOMI FUKAI)

Slide 1	Hello everyone. My name is Satomi Fukai. Today I'd like to demonstrate how to use optical communication using an LED and a solar panel. I'd like to start by introducing myself. I'm from a place in Japan called Hiroshima.
Slide 2	This map shows where Hiroshima and Houston are. It takes about 12 hours by airplane across the Pacific Ocean. First, I'd like to talk about Hiroshima, where I live. Have you ever heard of Hiroshima before?
Slide 3	Hiroshima is on the west side of Japan. It has mountains, rivers, and is next to the sea. It's a place with a long history.
Slide 4	There are two very fames sites in Hiroshima. One is the Atomic Bomb Dome. 70 years after the end of world war 2, this dome still remains standing as a symbol of peace. The other one is Itsukushima Shrine. This is a beautiful shrine that was built in the sea about 1000 years ago.
Slide 5	The school that I work at is in Etajima city, which is located on the largest island in Hiroshima prefecture.
Slide 6	Etajima city is surrounded by a calm sea. Oyster farming is a very big industry in Etajima city.
Slide 7	Here, I have a trivia quiz!! If you line up the shells of all the oysters eaten in Hiroshima, front to back, in one year, how far would they go?
Slide 8	I work at Noumi Junior High School.
Slide 9	Noumi Junior High School has many events such as sports festivals and chorus contests. At Japanese schools, a bell always rings at the end of class and at lunchtime. But at my school, there is no school bell. So students need to learn to manage time on their own.
Slide 10	At the school, there are many students who are interested in space and stars. They watch the stars and look at the international space station together when the weather is good.
Slide 11	I too am very very interested in space. Last year, I have been to see JAXA facilities all over Japan. JAXA is Japanese NASA. I also attended a presentation about a space robot called "Kirobo." Kirobo is a robot that can think for itself.
Slide 12	One day, a student saw a ship floating in the sea and asked me this question. "Why don't ships get lost in the vast ocean? How do ships know where they are??" "That's a good question," I replied. There are a few ways that a ship can find out where it is right now. Of these, I explained about ships finding out their location with GPS, which uses satellites and radio waves, just like car navigation systems.
Slide 13	Then the student asked another question. "I've seen a satellite, but I've never seen a radio wave. Can you see a satellite communicating with your eyes??" I replied, "Hmmm, That's difficult to answer..." So I checked if there were any satellites that communicated using visible light, which is

	light you can see.
Slide 14	There are many satellites around the earth. However, most of these use radio waves to send messages. And there were none that communicate with visible light.
Slide 15	However, there was a satellite that communicates using an infrared laser, which is close to visible light. This satellite is called OICETS an optical relay satellite. OICETS communicates using light, rather than radio waves. It communicates with other satellites and ground stations.
Slide 16	So how exactly does this communication using light work? To find out, I looked into how communication itself works.
Slide 17	Communication is defined as "giving information to another party." The simplest form of communication is a conversation. In a conversation, your voice reaches the other person because the sound vibrations travel through the air. OK, I'd like everyone here to try communicating by talking to the person next to you! Thank you, did you enjoy your conversation?
Slide 18	Voices are capable of producing many different vibrations. This is an example of vowels in Japanese. This doesn't just happen with voices; vibrations change with any difference in sound.
Slide 19	Next, here we have a string telephone that we can use for communicating with someone who is further away from us. Your voice reaches the person who is far away from you because the vibrations of your voice are changed to vibrations in the string to transmit the information. Today I've brought a string telephone with me. I used it at my school, and the students loved it! I'd like to give it a try with you, too. OK, we'll leave it there. Thank you.
Slide 20	Next, we can use a telephone for communicating with someone who is further away from us. Your voice reaches the person who is far away from you because the vibrations of your voice are changed to electrical signals to send the information. Today... I didn't bring a telephone with me, but you can try this using the telephone at home!
Slide 21	Finally, we have optical communication, witch is using light to communicate. This changes sound vibrations into electrical signals and then into light in order to transmit information, and a person in a far away place can hear your voice by changing this back to an electrical signal. Contrary to the infrared communication as in OICETS, you can also communicate with visible light.
Slide 22	OK, let's use an LED and a solar panel to try this communication technique ourselves.
Slide 23	You need to prepare these seven things. When you are doing the experiment, make sure the room is dark.
Slide 24	There are few things you need to be careful about when you do this experiment. Please don't look straight at the light from the LED as you might damage your eyes. Also,

	please don't shine the LED on anyone's face.
Slide 25	First, let's make the light receiver. Connect two electrical clips to the pin plugs on the speaker. Next, connect the ends of the electrical clip to the positive or plus and negative or minus terminals of the solar panel. The light receiver is now complete.
Slide 26	Next, let's make the light transmitter. Turn on the radio, and tune it to whichever station you like. (Tuning) We next insert the speaker cord into the earphone jack on the radio. Next, put the long wire of the LED on the positive or plus terminal of the button battery and the short one on the negative or minus terminal to light up the LED.
Slide 27	Once the LED is lit, place the ends of the speaker cord on the positive and negative terminals of the button battery. Hold the LED and end of the cord firmly to make sure they stay in contact with the panel. The light transmitter is now complete.
Slide 28	OK, let's shine the LED light on the solar panel and start our optical communication. You can find the explanation I've given you so far in the instructions on your desk. Follow these while you do the experiment. If you have any trouble following the instructions, please ask me.
Slide 29	How did your optical communication experiment go? Let's try blocking the LED light with our hands and being the LED closer to the solar battery, then move it farther away until you can no larges hear the radio. OK, we've run out of time so let's leave things there.
Slide 30	Finally, I'd like to talk about the future of optical communication. Currently Japan uses the Kodama satellite to relay data between satellites and enable communication with far away places. Kodama communicates using radio waves. However, development of a satellite with a communication circuit that uses light instead is underway. Light has a higher frequency and shorter wavelength than radio waves, so it enables high speed and high capacity communication.
Slide 31	An optical data relay satellite that carries on the technology from the test satellite Kirari (OICETS) is planned to be launched and put into service in 2019. This optical data relay satellite will also be used for a range of earth observation missions in the future.
Slide 32	Through the optical communication experiments I have performed with students, I myself have discovered more aspects to space and science. Based on a little question from a student, I want to keep making teaching materials that will get everyone excited about science.
Slide 33	As a present, I'd like to give everyone the button batteries and LED used in the experiment today. If you felt that this optical communication experiment was interesting, please try it at your school or some other place.
Slide 34	That's the end of my talk. Thank you for your attention.