

# **Introduction to Electrical Engineering and Computer Science**

Communication & Information Engineering & its  
Applications to Radio Science

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# The knowledge that I got from the lecture

## Space

**Space environment & human life** : These days, we depend on the space systems such as communication satellites, broadcast satellites, meteorological satellites and global positioning system (GPS) satellites for many of our modern convenience and for navigation. The construction of the International Space Station and space travel planned by private sectors increase the potential of civilians visiting space. Many risks are associated with the environment in space, such as radiations hazards that astronauts face, single event upsets of electrical equipment on satellites, degradation of solar panels. In addition, geomagnetically induced currents associated with intense geomagnetic storms sometimes cause problems on power grids on the Earth[1].

So we need to define what space environment is. the Space Environment is the region beginning at the lower boundary of the Earth's ionosphere (approximately 50 km) and extending outward that contains solid particles (asteroids and meteoroids), energetic charged particles (ions, protons, electrons, etc.), and electromagnetic and ionizing radiation (x-rays, extreme ultraviolet, gamma rays, etc.).

Now we see that the space environment effects to our earth and let's look a little about it. Before we begin we need to know the term "Space Weather". The Space Weather is the concept of changing environmental conditions in outer space. It is distinct from the concept of weather within a planetary atmosphere, and generally deals with the intersections of ambient radiation and matter within interplanetary, and occasionally interstellar space[3].

From the definition of the National Academy of Science: "Space weather describes the conditions in space that affect Earth and its technological systems. Our space weather is a consequence of the behavior of the sun, the nature of Earth's magnetic field, and our location in the solar system."[1].

Our earth is surrounded by the magnetic field that prevents radiation from the sun which is produced by the explosions at the sun. So it is very important to understand the behavior of the sun and the nature of the magnetic field. Figure 1 shows the example of the earth's magnetic field. The measurements of plasma waves is one of the important thing to study in space environment.

## Japanese scientific activities in space research

Japan launched several satellites in the past and will continue to launch in future. In 1989 and 1992, the satellites, Akebono and Geotail, to the space. Akebono's mission finished in 2015. In 2016, ERG(Arase) was launched and it is operating in the space. In 1998, Japan launched Nozomi to the Mars, but the mission failed. In 2007, Japan successfully launched Kaguya to the Moon. In this year, BepiColombo/MMO will be launched to the Mercury by the project which is operated by the collaboration by Japan and EU[1].

After several years of service, Akebono provided a large numbers of space data. It contained several instruments such as, DC Magnetic Field, DC Electric Field, Ion & Electron Detector, High Frequency Wave Receiver (20kHz - 5MHz), Low Frequency Wave Receiver (0 - 20kHz) and Visible and UV Auroal Image. By using Low Frequency Wave Receiver, approximately 1.5 TBytes of digital data was received and stored in 28,000 tapes of Analog Waveform data (approximately 20TBytes)[1].

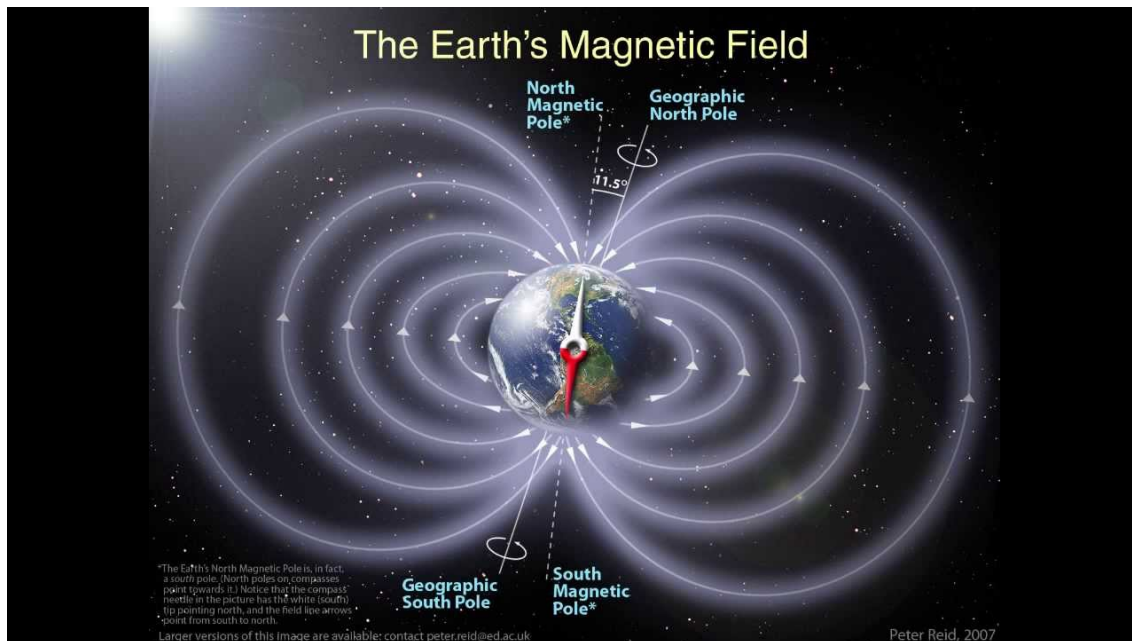


Figure 1: The Earth's Magnetic Field.

[2]

## Intelligent Signal Processing Onboard Spacecraft System

**How to send the data to the ground:** There are magnetic sensors that are installed on the instrument. These sensors measure the space magnetic environment and send the information to the receiver which is also located in the instrument. Then the receiver processes the raw data to send back to the earth. Before sending, the raw data was processed by onboard CPU such operation as compressing the data and so on and then send the data back to the earth. The tracking station then receives the data sent to the database. The ground data process is done at the final step[1].

For Bepi Colombo Mission, there are some interesting things. The distance is so far from the earth and the ground crews must make sure that the satellite can operate properly. More importantly, the data from the satellite should be successfully sent to the earth. There are three modes: LOW-mode, Medium-mode, and High-mode which have 0.5kbps/ave, 1.0kbps/ave, and 1.0kbps/ave. So we can see that it will be very difficult to obtain many data with this kind of data transfer rate[1].

That is the reason that Mission Data Processing (MDP) software is very important. The data storage in the MDP will be divided into many ring-buffers. One long buffer and one short buffer will be allocated to each sensor. In nominal, mission data will be stored in the long buffers and "L/M mode" data will be produced. In "H-mode" operation, data in the long buffers will be preserved for data production of "H mode" data and short buffers (~12s) will be used for the continuous "L/M mode" data production[1].

## SCOPE Mission

This mission is formation flying satellites that contains one mother satellite, one daughter satellite (near distance of 10 ~ 100km), and three daughter satellites (far distance of 100 ~ 5000km). This is the Co-operational observing using Inter-satellite communication system. So network configuration of the simulator is used to

test various environments. There will be three satellite PCs which are one mother satellite and two daughter satellites. Another PC is to simulate the space.

## How to make spacecraft

It is very important that the electronic equipments survive in the space environment. The rate of changes of temperature in the space is very high in the space. So it is very important that the heat which is produced from the electronic equipment must be as low as possible. To make sure that the equipments are resistant to the high temperature, the equipments must pass several tests on the ground. Another problem is the vibration at launching and operation. The equipments must be tested for the vibrations test. After several tests, the equipments are moved to the launch site and tested again. After final function test at launch site, the satellite is put in the spacecraft and fairing assembly. Finally, the satellite is launched to the space by using rocket[1].

## Interesting Part

The most interesting thing for me about this lecture is how to send much data using such low data transfer rate. The other thing is implementing the space simulator that can support for the researchers with low budget. The final interesting thing is software implementation that can operate in very low performance hardware that is used in the space system.

## My Impression

I was really impressed about listening this lecture. I have watched documentaries for such kind of things. But this is my first time that I have listened to the lecture about space from a professor who is participating in the real world project. This is very tough job for the participants of this kind of projects. All people may feel a high pressure. I thought that the equipments used in the satellite are high performance machines and only such kind of high performance CPU, Memory and etc., can operate the operation in the space. But my thought was wrong. The low performance device should be used because of the heat produced by the equipments. This is really impressed to me.

## Difficult to Understand

It is not possible to understand deeply about these things in one lecture for a person who is new to this kind of area like me. The thing that I want to know is that if the satellite is lost connection with the ground, how to recover the satellite.

## Other Comments

I would like to say something about this section. There may be young people in my country, Myanmar, who are interested in this kind of area. But they have less chance to study about this area. It will be very good that if they have the chance to study at the labs at Kanazawa University. But most of our people are not rich, so those young people could not effort to study at the Kanazawa University. My

suggestion is if they have the chance to get scholarship to study at the Kanazawa University, this will be a good opportunity for the young people in Myanmar.

# References

- [1] Prof. Yoshiya Kasahara. Introduction to electrical engineering, 2018.
- [2] typealt. Earth's magnetic field - an explanation, 2013.
- [3] [www.thefreedictionary.com](http://www.thefreedictionary.com). Space environment, 2018.