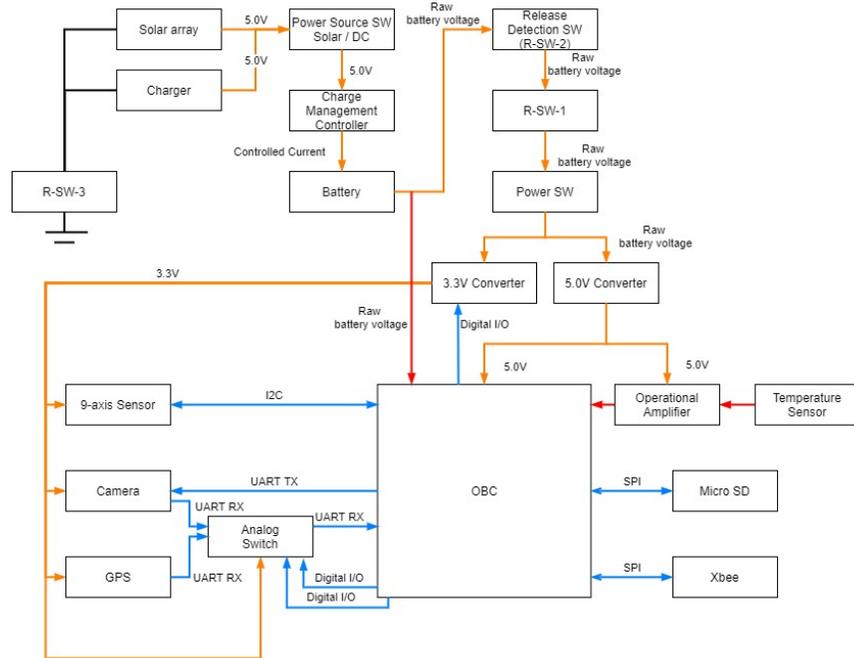


Model-Based Engineering Education with Practical Activities Using HEPTA-Sat



System Model



Satellite



Nihon University

○Takumi Sato

Taiga Zengo

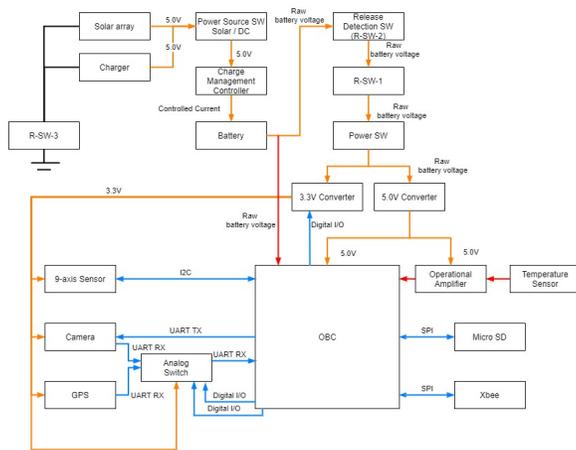
Masahiko Yamazaki

1. Research Summary



As a method of human resource development that can lead to the success of "satellite development which is a complicated system"

Think of a satellite system and represent it with models



System Design

Assembly, Integration & Test (AI & T) of the hands-on kit



HEPTA-Sat

To learn the ideas and knowledge necessary for satellite system design



MBSE Class Scene



2. Research Background



- **Model-Based Systems Engineering (MBSE)**

- **Good points of MBSE**

- ✓ The ambiguity of information can be clarified
- ✓ The related information can be linked and managed

- **Previous Research**

- **MBSE education**

- Development of CanSat and CubeSat



- Education span that takes more than half a year
- A certain number of people are required for the project



- Short term education span
- Projects that are easy to work on a personal level

3. Purpose of Research



As a method of human resource development that can lead to the success of “satellite development which is a complicated system”

Projects that are Easy to work on a personal level

- ◆ Assembly, Integration & Test (AI & T) of the hands-on kit
- ◆ Present an example of a satellite system shown in model diagrams
- ◆ Learn about each satellite system using textbooks



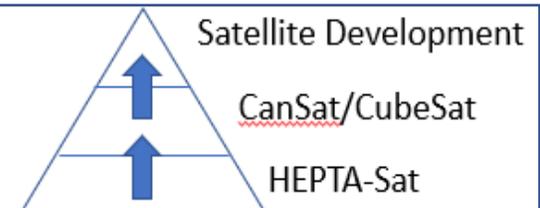
Short term education span

- ◆ Learn satellite systems step by step
- ◆ Assemble a satellite system without any special technology

As a spillover effect

Increase human mobility throughout satellite development

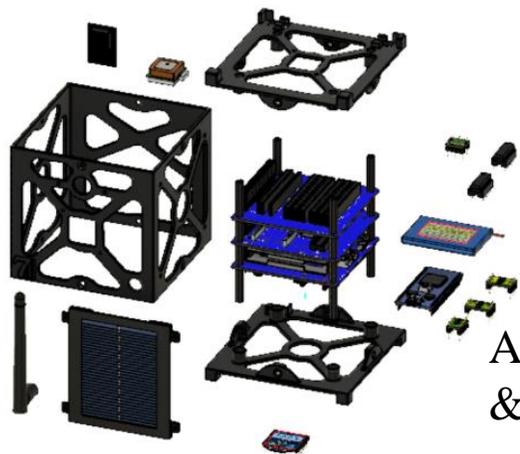
Develop human resources



4. Research Approach



Educational design that enables "Projects that are Easy to work on a personal level" and "Short term education span"



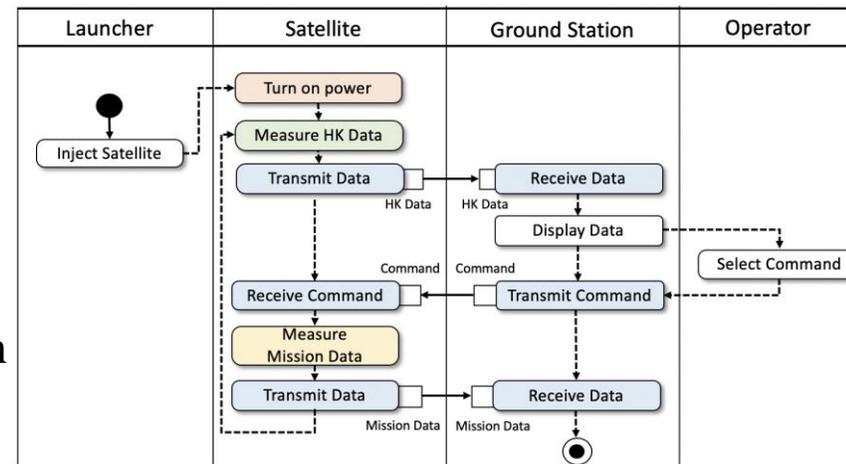
Assembly, Integration & Test (AI & T)



System Design



sensor



Mission design and system design with the physical system once learned

Learn about each satellite system using textbooks



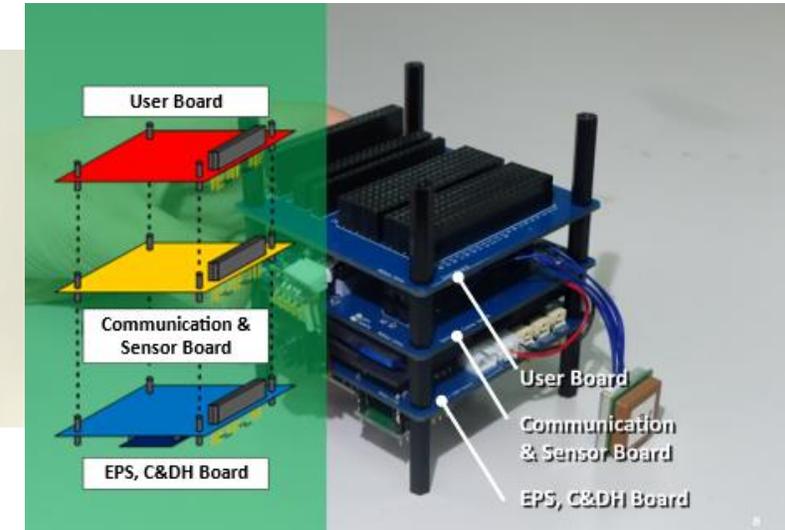
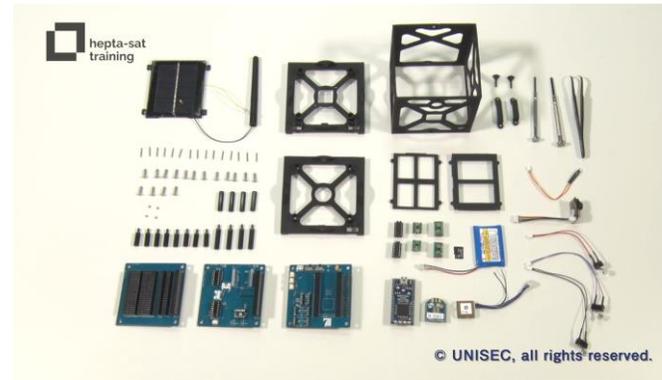
1week educational span



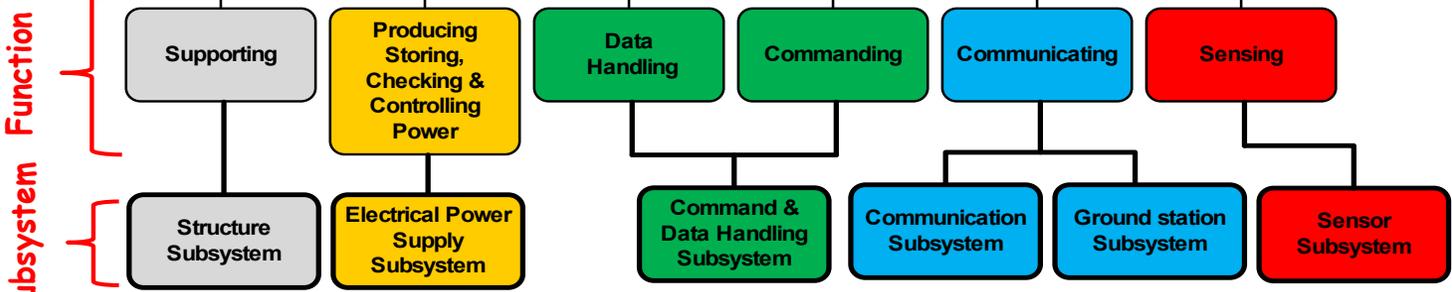
5. CubeSat educational kit "HEPTA-Sat"



"HEPTA-Sat" enables "Projects that are Easy to work on a personal level"



HEPTA-sat



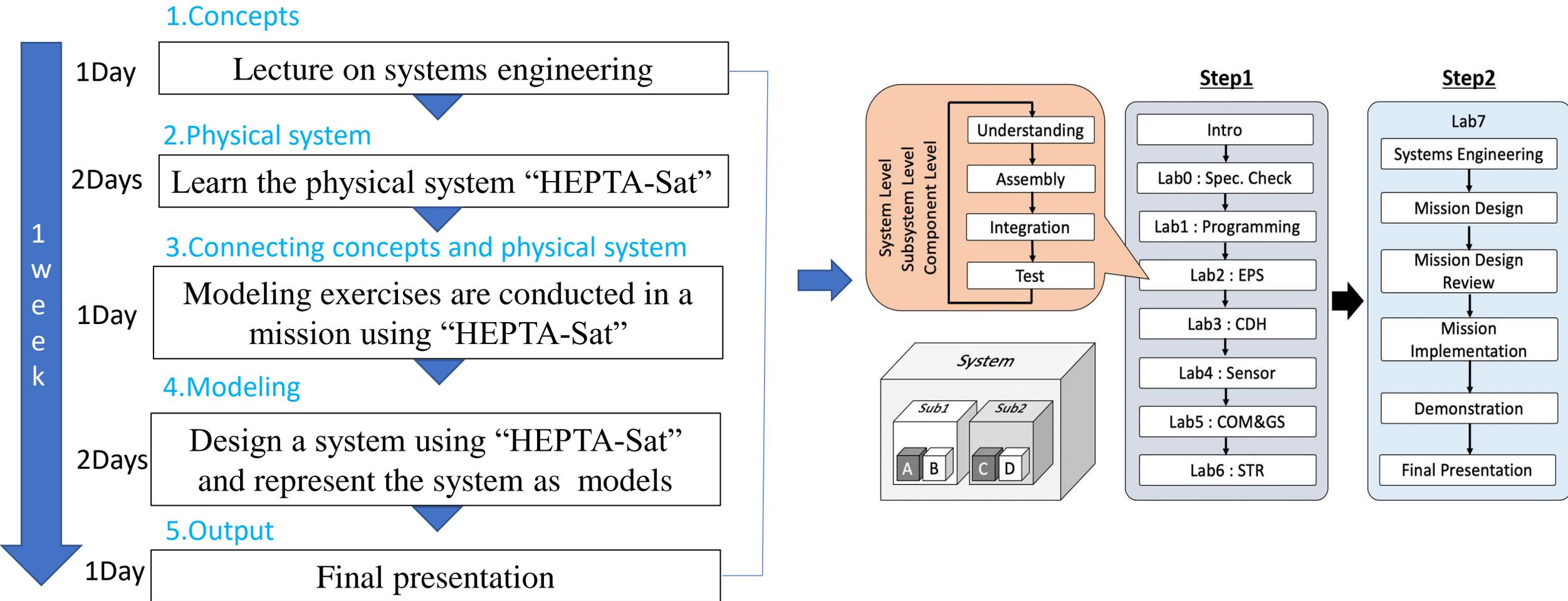
Inserting them into sockets, and the components can be easily removed.

Equipped with 6 subsystems that incorporate the 6 basic functions of a satellite

6. Feasibility of short education span



Educational design that enables "Short term education span"

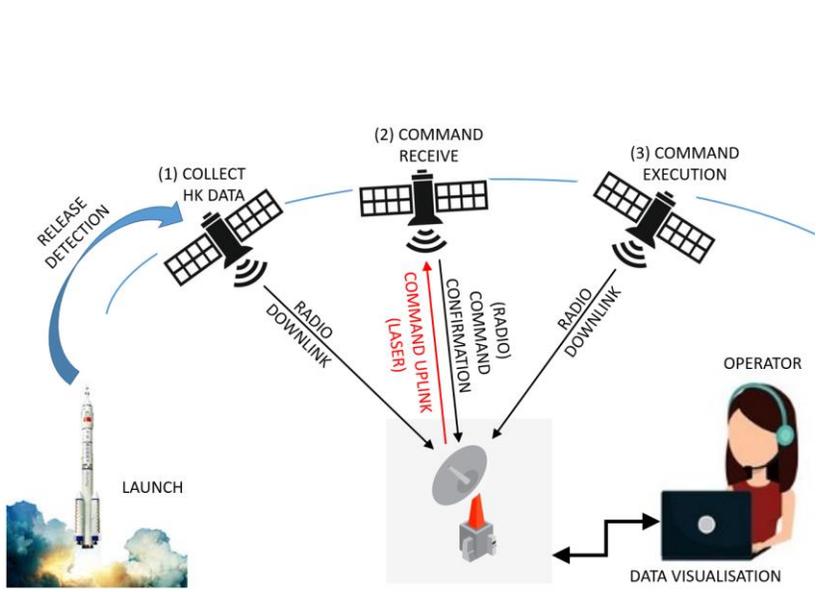


7. MBSE education using HEPTA-Sat

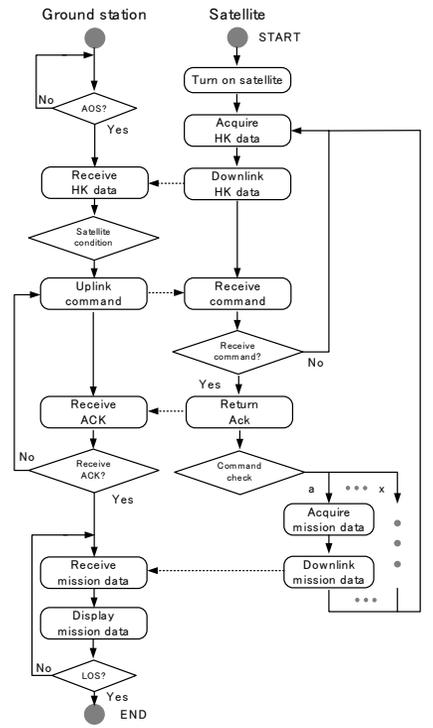


It is effective to think about at least three aspects in system design

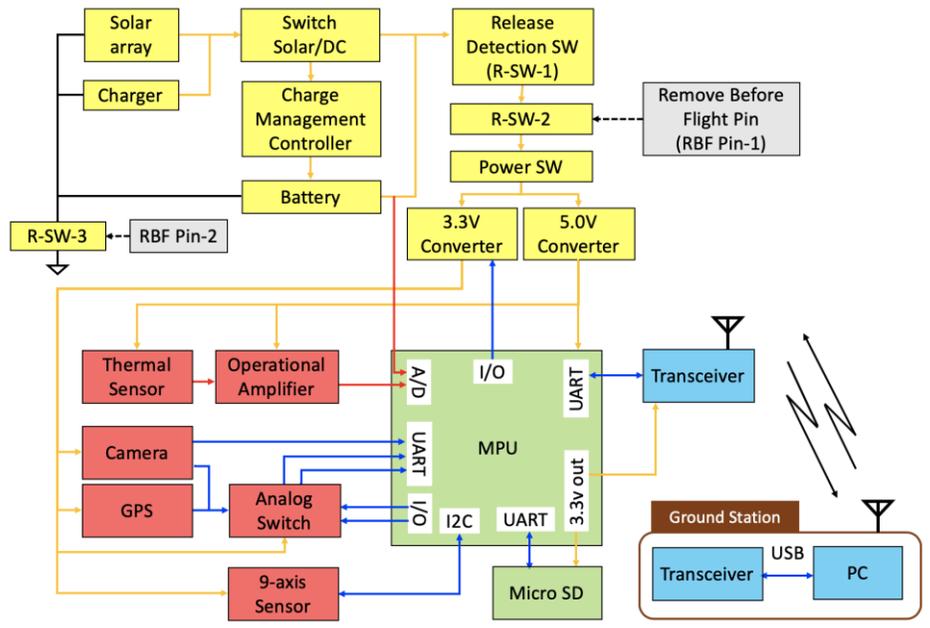
Operational View



Functional View



Physical View



what you actually want to do and how to relate to other systems

what functions they have and how they are related

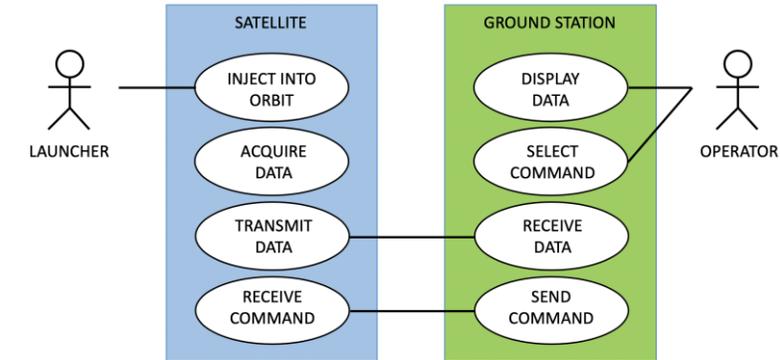
what kind of hardware and software configuration to use

7.MBSE education using HEPTA-Sat Training

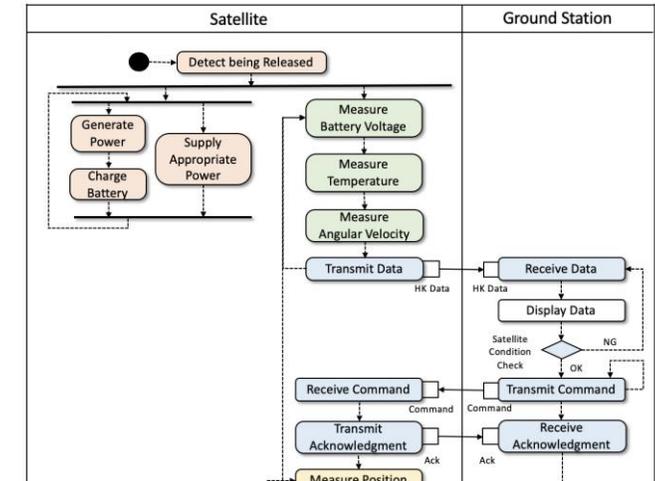


Five states in the system are represented by five models

View	Definition	Model Diagram	
		Static	Dynamic
Operational	How to use or operate system	Use case diagram	Activity diagram
Functional	Functions required in system	Block definition diagram	Activity diagram
Physical	Hardware&Software Achieve functions	Internal block definition diagram	



Static Model



Dynamic Model

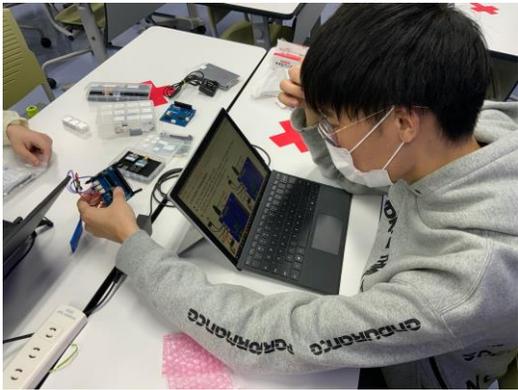
8. Results of the proposed method



MBSE class using "HEPTA-Sat"



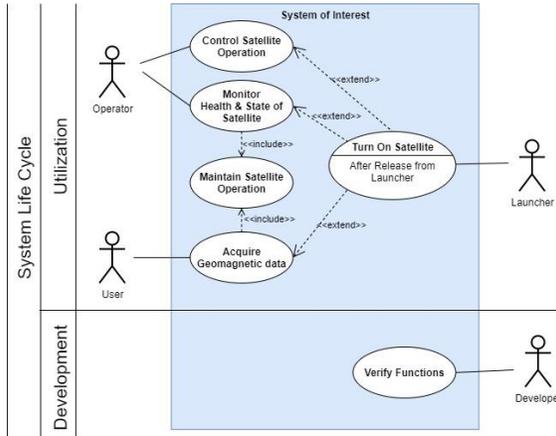
MBSE Class Scene



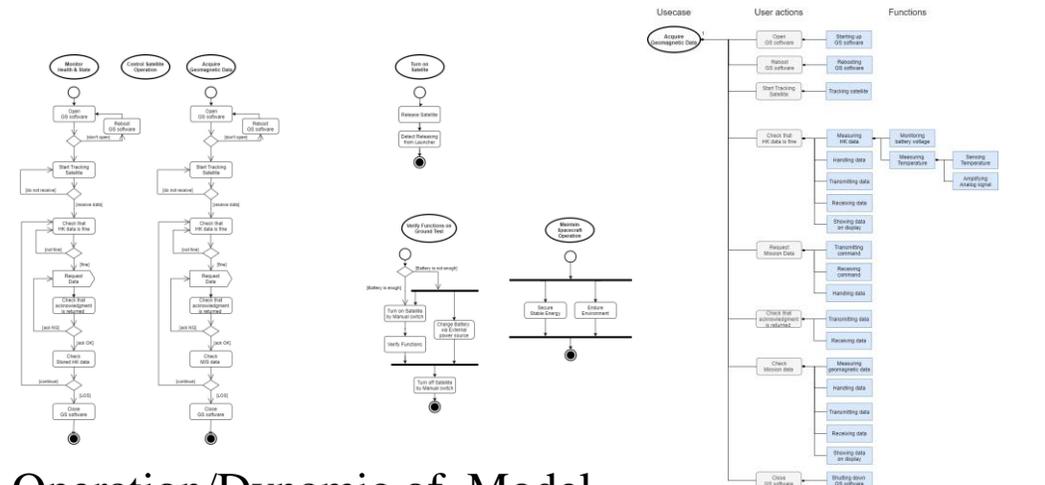
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6 From Sat : Operation Start...
HEPTASAT::Condition = 0, Time = 0.000000 [s], BatVol = 3.54 [V],Temp = 26.29 [C]
HEPTASAT::Condition = 0, Time = 1.000000 [s], BatVol = 3.54 [V],Temp = 26.08 [C]
HEPTASAT::Condition = 0, Time = 2.000000 [s], BatVol = 3.53 [V],Temp = 26.24 [C]
HEPTASAT::Condition = 0, Time = 3.000000 [s], BatVol = 3.53 [V],Temp = 26.29 [C]
HEPTASAT::Condition = 0, Time = 4.000000 [s], BatVol = 3.53 [V],Temp = 26.13 [C]
HEPTASAT::Condition = 0, Time = 5.000000 [s], BatVol = 3.54 [V],Temp = 25.98 [C]
HEPTASAT::Condition = 0, Time = 6.000000 [s], BatVol = 3.51 [V],Temp = 26.08 [C]
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HEPTASAT::Condition = 0, Time = 8.000000 [s], BatVol = 3.53 [V],Temp = 26.44 [C]
HEPTASAT::Condition = 0, Time = 9.000000 [s], BatVol = 3.53 [V],Temp = 26.29 [C]
HEPTASAT::Condition = 0, Time = 10.000000 [s], BatVol = 3.53 [V],Temp = 26.90 [C]
HEPTASAT::Condition = 0, Time = 11.000000 [s], BatVol = 3.53 [V],Temp = 26.65 [C]
    
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Assembly, Integration & Test (AI & T)

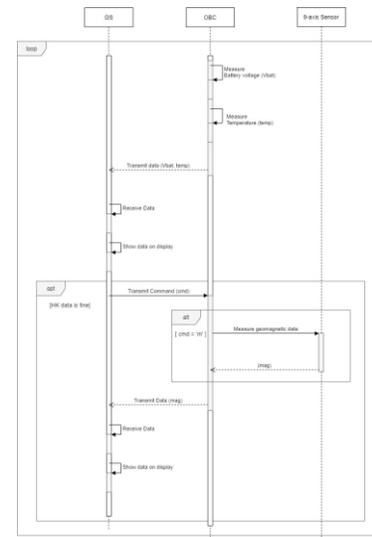


Operation/Static of Model

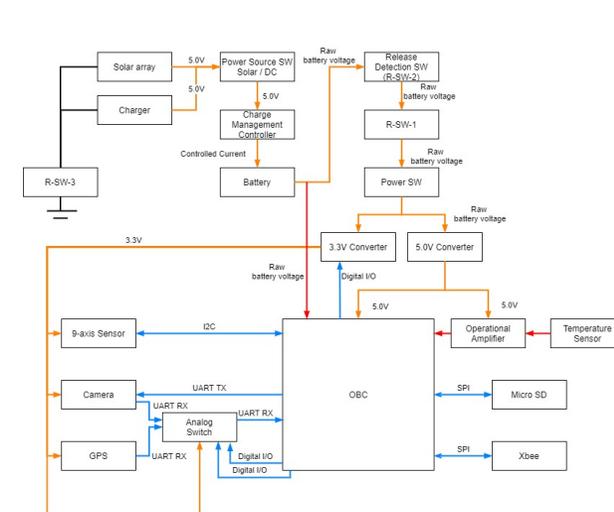


Operation/Dynamic of Model

Function/Static of Model



Function/Dynamic of Model



Physical/Static of Model

9. Future Prospects

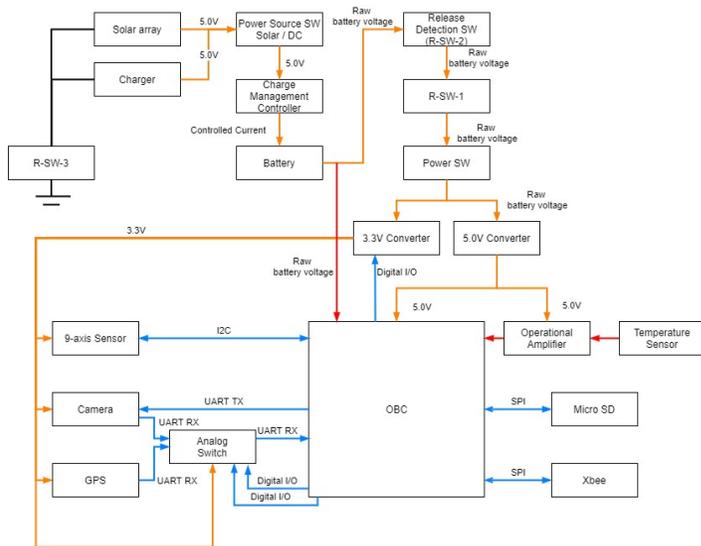


Future Prospects for MBSE education using HEPTA-Sat

- ❑ HEPTA-Sat can be assembled from component units without soldering techniques
- ❑ It is easy to see the connection between the physical system and the model.
- ❑ Increase the number of group work
- ❑ Teaching the model with an example of a mission tailored to HEPTA-Sat
- ❑ Increase the number of cycles between input and output

Model-Based Engineering Education with Practical Activities Using HEPTA-Sat

Thank you for your attention



System Model

Satellite