

TRISMAC2024

Digitalization(MBSE)/Digital Engineering and Assurance

# The Design Digitalization Strategy Progress of NEC Space Technologies

Kazuki Watanabe

NEC Space Technologies

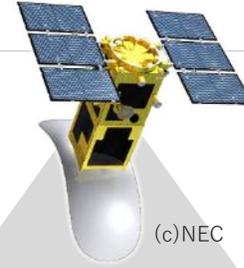
June 24<sup>th</sup> , 2024

# Agenda

1. Introduction
2. MBD(1D-CAE)
3. MBSE
4. Conclusion

# NEC Group Space Business Overview

NEC Corporation's Space Business



(c)NEC

Satellite System

- ✓ Development, assembly, and testing of Satellite System

Sub-System

- ✓ Development, assembly, and testing of Sub-System

NEC Space Technologies, Ltd.'s Space Business



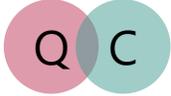
- ✓ Development, assembly, and testing of equipment for satellites and rockets

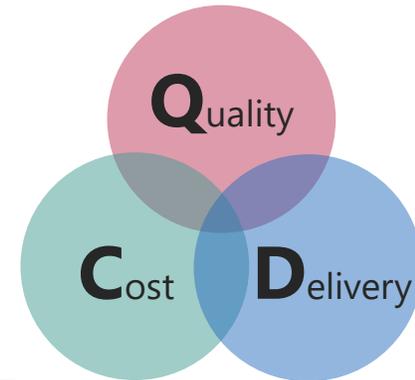
Equipment for Satellites and Rockets

Components for the Equipment

- ✓ Development, assembly, and testing
- ✓ Machining, PCB mounting/testing

# Introduction ~ Background ~

- ◆ As Customer Demand is higher,  System is more complicated and Technical Difficulty is higher.
- ◆ For Shorter Project period,  BBM/EM, PFM/FM development periods tend to be intermingled.
- ◆ It is obvious Conventional Development process will not be able to meet the  demands in near future...



**Transformation of the development process is required :**

- **Digital Transformation is a mainstream in manufacturing industry**
- **Design process is also shifted to Digitalization based on MBSE and MBD**

## ◆ **Advanced in Automotive industry**

- **Mazda successfully incorporated MBD and improved QCD process (Mazda Technical Report, in 2013)**

## ◆ **Expanded in Space industry**

- **NEC/NECSpace are successfully utilizing MBD for different designs of satellite system and component (MATLAB EXPO 2023 Japan)**

# What is MBSE/MBD?

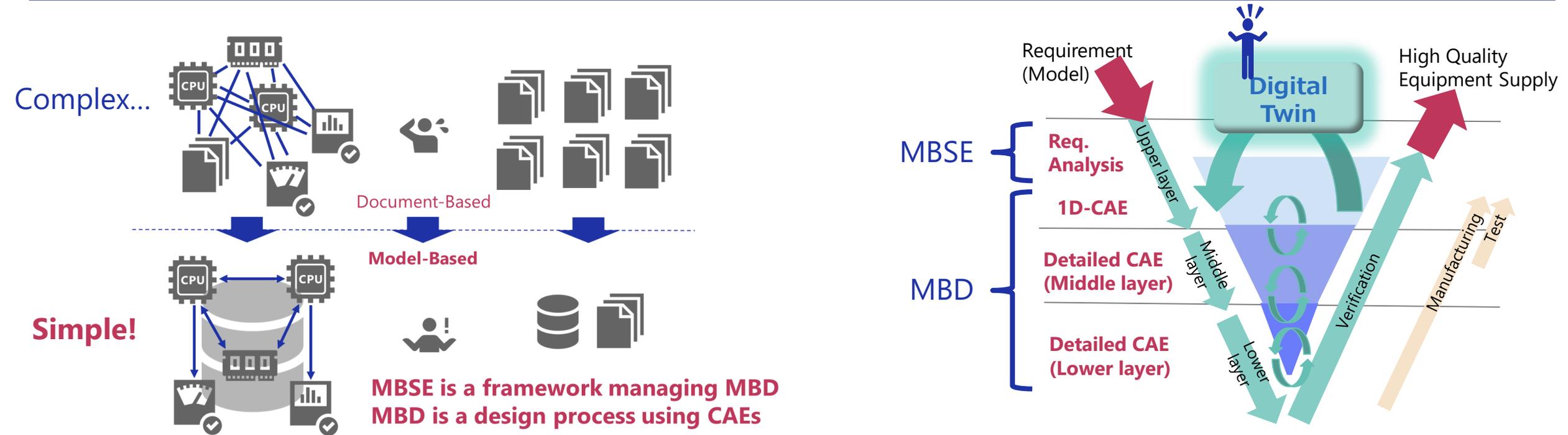
## MBSE: Model-Based Systems Engineering

Design methodology representing the requirement and specification as a model using modeling languages(UML/SysML etc.) and managing a series of design process digitally

## MBD :Model-Based Design/Development,

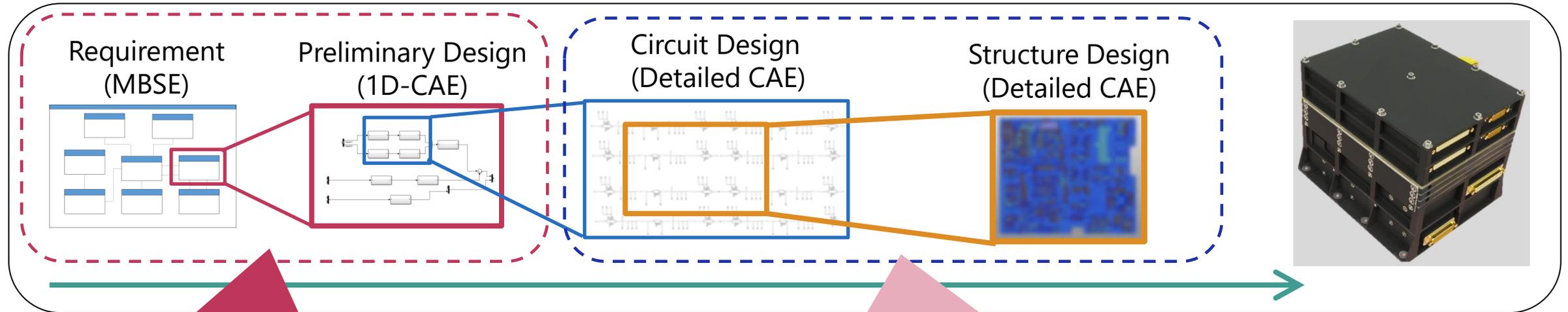
Verifying the achievability of the specification using CAEs\*, resulting in fewer number of prototyping and shorter development period

\*CAE: Computer Aided Engineering(Simulation)



# Design Digitalization Strategy of NEC Space Technologies

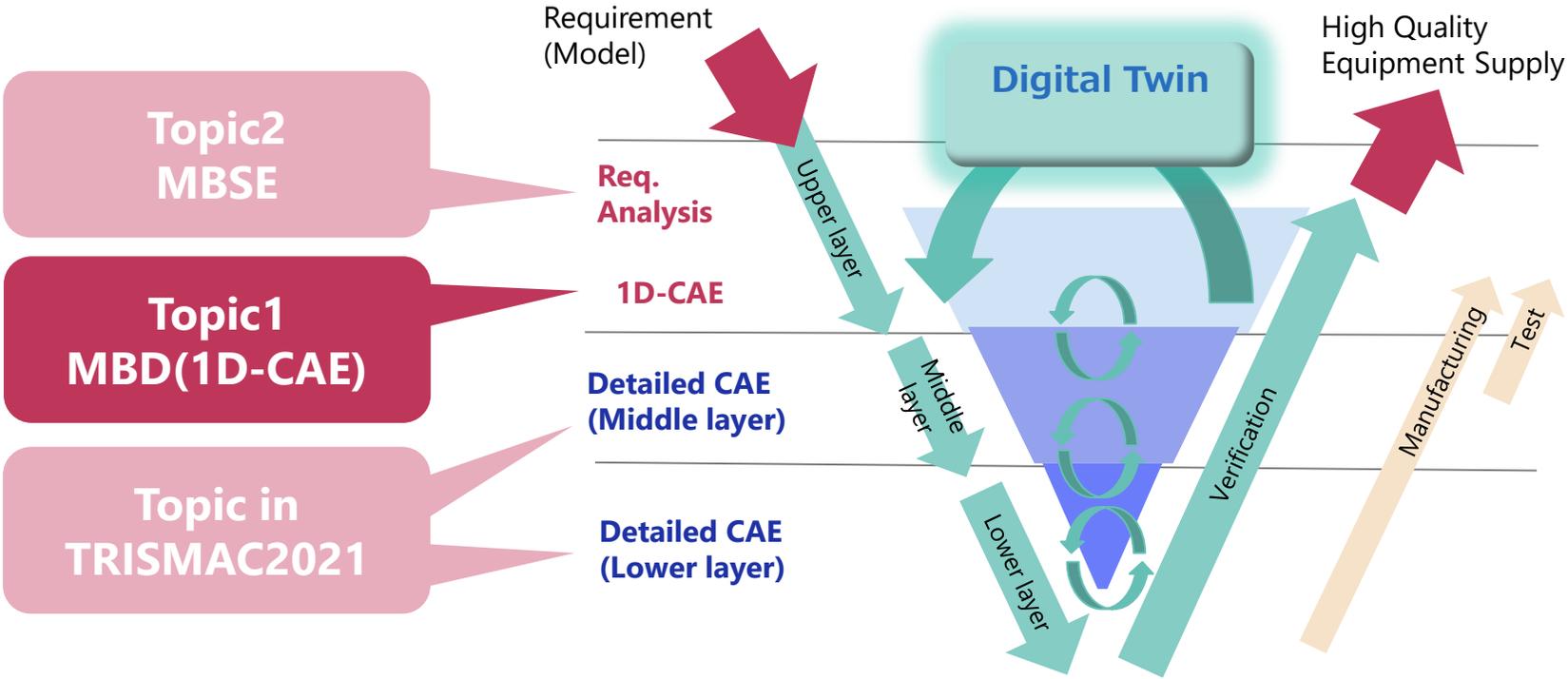
- QA dept. plays a roll of “MBSE/MBD evangelist” for design dept.
- Modeling stages are categorized to requirement, 1D-CAE and detailed CAE and the appropriate approaches are applied on each stage



**This time, we will report the enhancement activities of MBSE and 1D-CAE**

**We mainly reported the enhancement activities of the detailed CAEs in TRISMAC 2021**

# TOPIC1. MBD(1D-CAE)



# MBD(1D-CAE) - Subject and measures

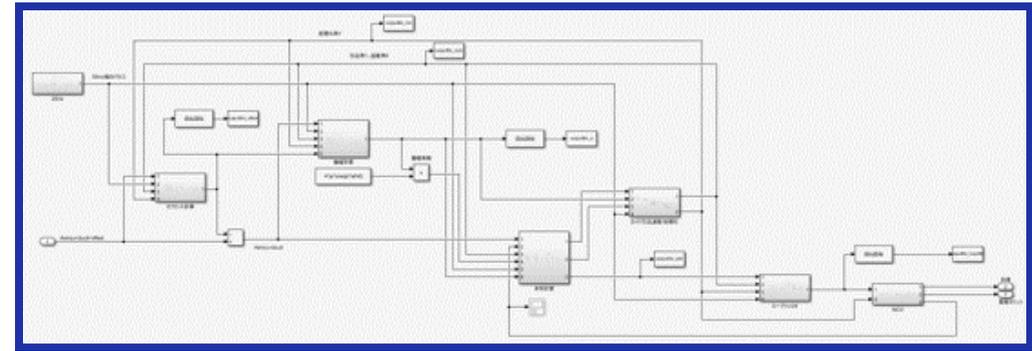
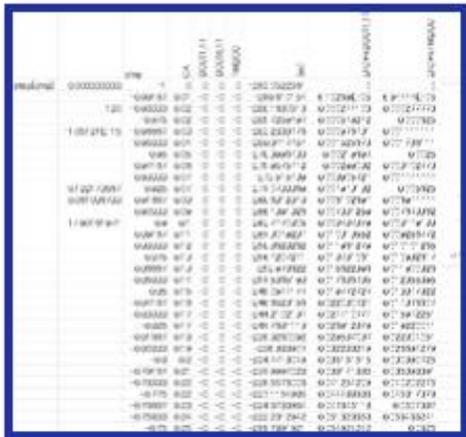
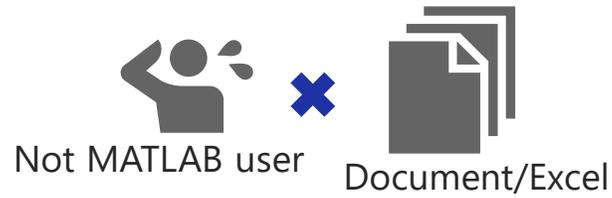
## ◆ Subject

- Wider uses of MATLAB/Simulink for a variety of components

## ◆ Measures

- QA dept. investigates which components have advantages by applying MATLAB/Simulink
- QA dept. supports initial setup of MATLAB/Simulink

\*MATLAB/Simulink: de facto standard tool of 1D-CAE  
supplied from MathWorks company



# MBD(1D-CAE) - Example 1

## Voices from designers

Difficulties in understanding the document/Excel-based veteran asset (complicated algorithms etc.)

Using Simulink



Enhance readability



We can describe the algorithm visually so that the designers can easily understand it.

Verify algorithm



Easy to modify when some changes are needed in algorithm.  
Verify the behavior in advance.

Make manual



We made some manuals including the explanations of formulas used in algorithms.  
The manuals with Simulink model are used for the veteran asset inheritances

# MBD(1D-CAE) - Example 2

## Situation

Require significant effort to read and code algorithm



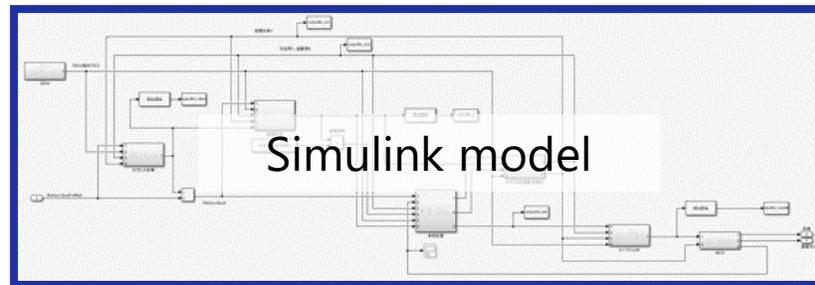
Using Simulink 's Auto-Coding add-in



Reduce the coding cost & time dramatically



Some conventional designers enjoyed quick generation of RTL-code from Simulink model  
QA dept. is also brushing up the guideline of auto-coding

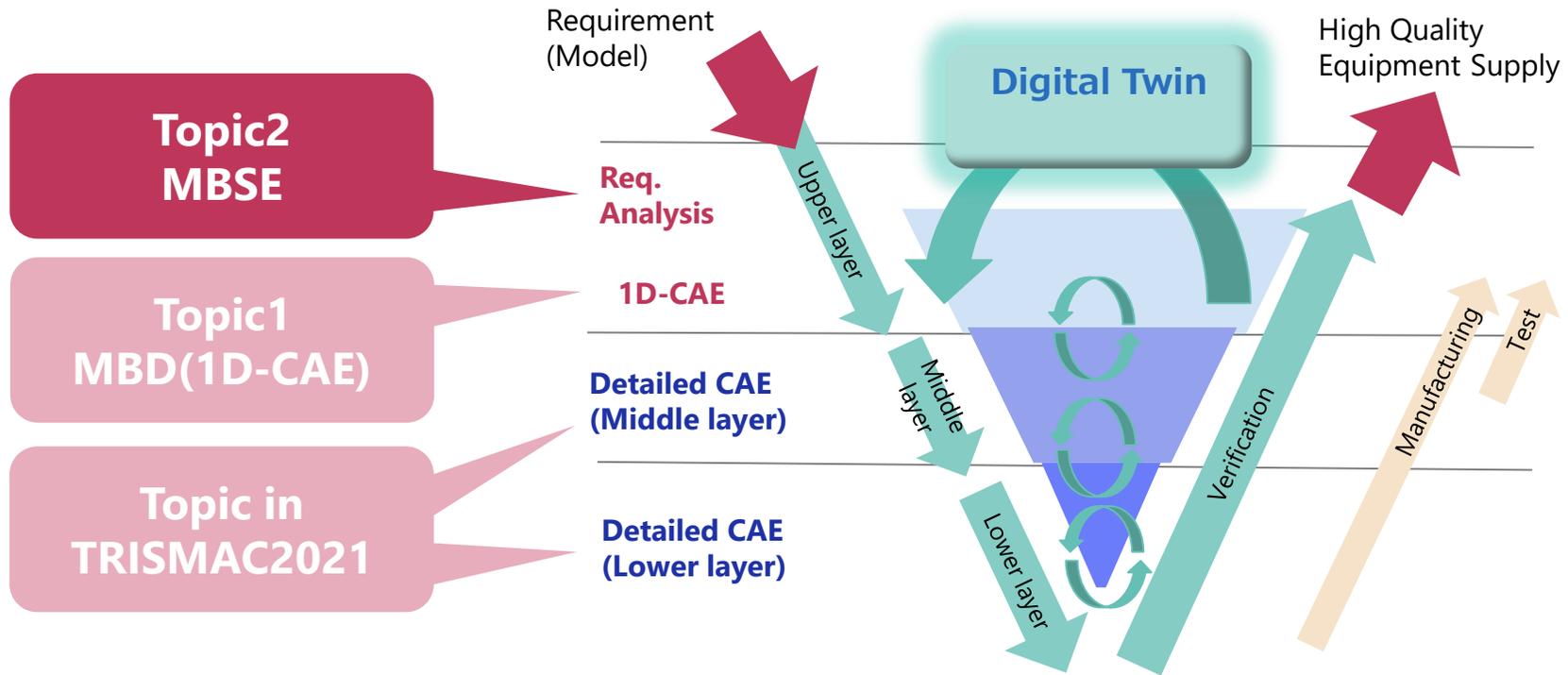


output



RTL/C

# TOPIC2. MBSE



# MBSE - Subject and measures

## ◆ Subject

- SysML's literacy enhancement and applying to the practical designs
- Verify the feasibility of SysML for collaborative designs between System and Components



## ◆ Measures

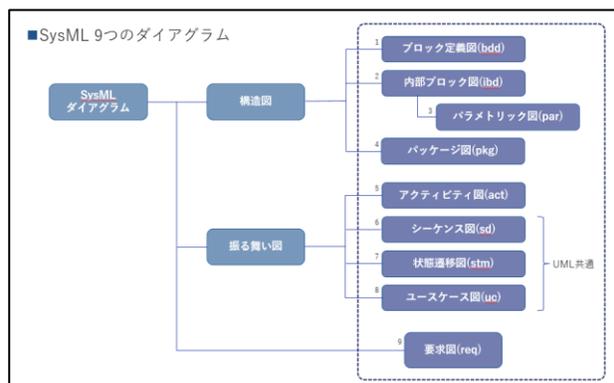
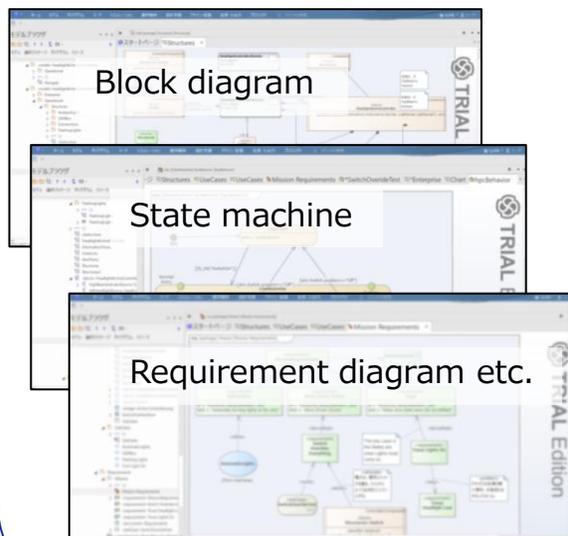
- We joined the education curriculum of SysML hosted by NEC, and then started our original education inside NECSpace
- We set up a WG with NEC in order to apply MBSE/SysML to different practical uses, from smalls to bigs.

\*SysML: Standard modeling language of MBSE derived from UML for applying wider uses of S&W/H&W designs

# MBSE - Measure 1

## SysML education introduction

### 1<sup>st</sup> stage Professional MBSE/SysML education hosted by NEC

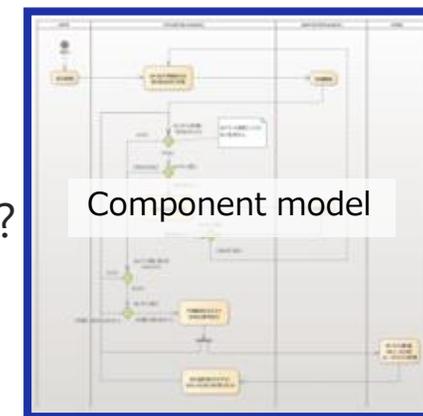


### 2<sup>nd</sup> stage Evangelistic MBSE/SysML education inside NECSpace

Evangelistic teacher of QA dept. teaches engineers with high motivations.

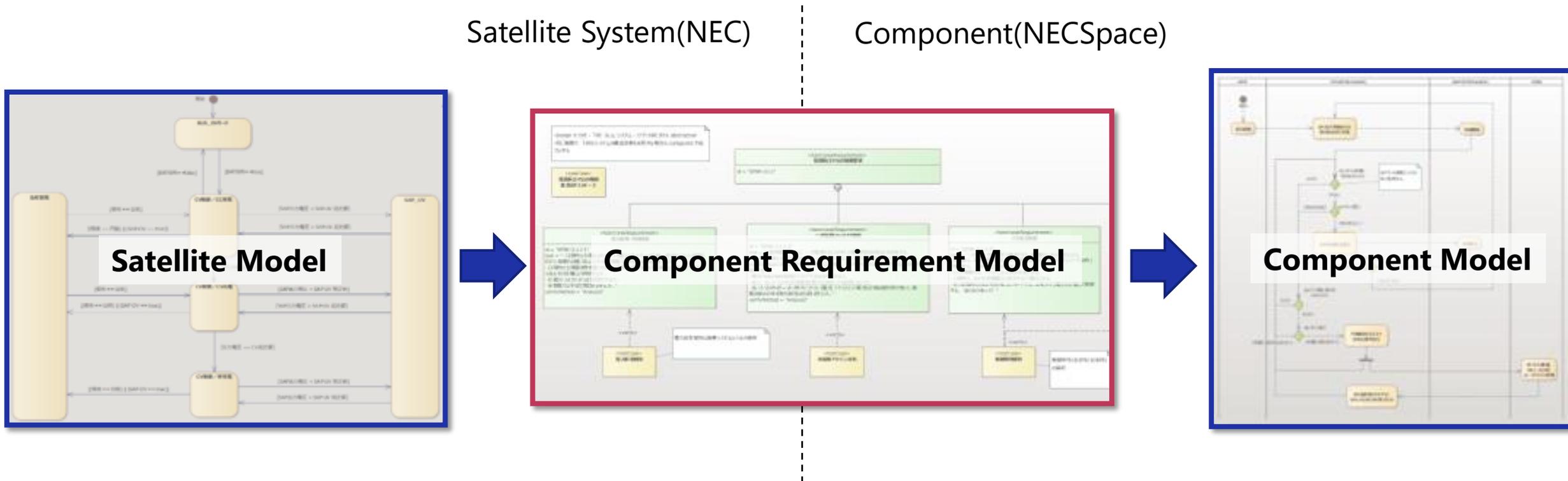


What is MBSE?  
How to make models?



# MBSE - Measure 2-1

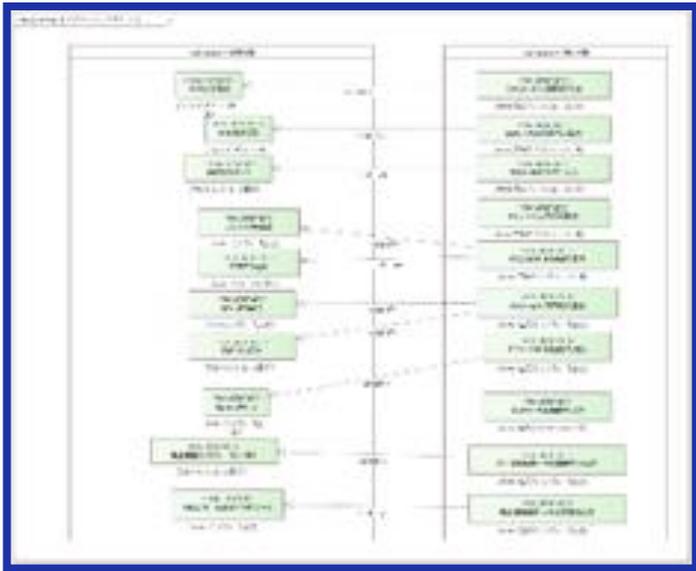
- Build and run the WG for SysML's practical uses
- Establish how to exchange the specification through SysML with NEC



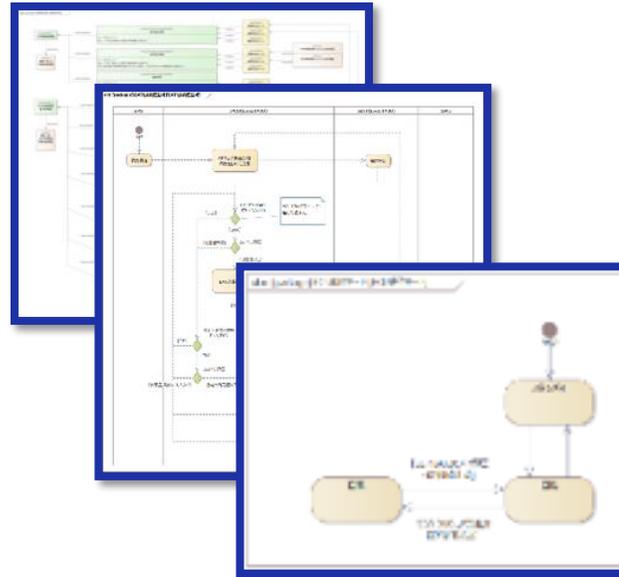
# MBSE - Measure 2-2

- Set up the model with traceability
- Make it easier to understand the impact of changes

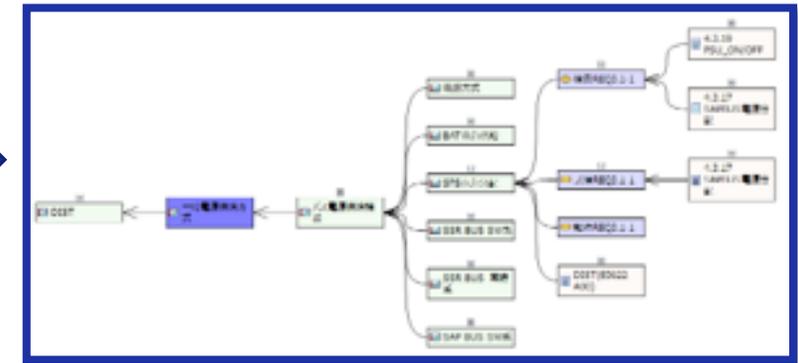
Define component spec by requirement



Create component model



Trace the scope of impact



Change requirement for spec A

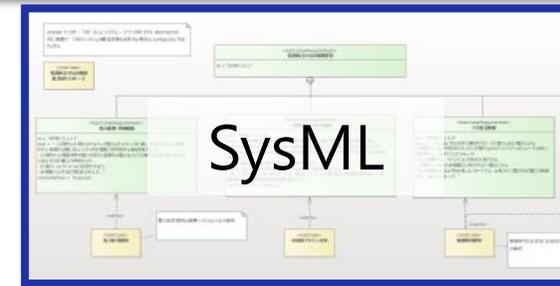
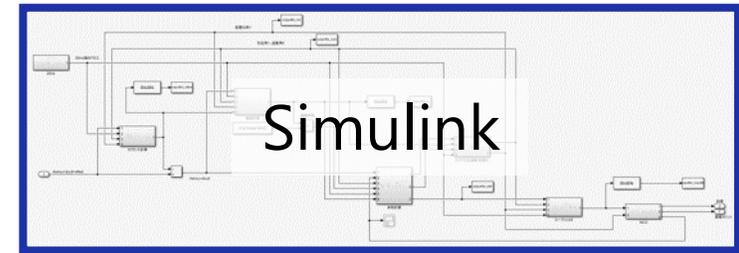
Some works are necessary:

- Change design for Circuit B
- Analysis for Circuit B
- Change Document C

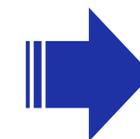


# Conclusion and future plan

- ◆ We explained the recent progress of our activities on MBSE/MBD in NECSpace, specially for 1D-CAE stage and MBSE stage
- ◆ In 1D-CAE stage, we are focusing on Simulink modeling of complex algorithm for veteran asset inheritance and auto-coding promotion for design cost reduction
- ◆ In MBSE stage, we are focusing on SysML education for literacy enhancement and establishment of specification exchange with NEC
- ◆ In future, we will standardize the Simulink, auto-coding, as well as MBSE/SysML utilizations in design process



Document-based  
Design



Model-based  
Design



In this way, we will contribute to the improvement of quality.

\ Orchestrating a brighter world

**NEC**