Toward space system modeling with appropriate scope and abstraction level based on validation against constraints

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Agenda

1. Our challenge
2. Proposal Method
3. Experimental Result

Introduction

■Issues

・Difficult to develop modeling rule to solve the development problems,
since SysML has widely representation and description for widely domains

-Not identifying verification cases because of inappropriate level of abstraction

・Identifying the scope of influence depended on “experience” and “intuition” of modelers in case of a change that affected the system architecture

For example: Design constraints by determining behavior

■Proposal

・Generating constraint-focused modeling and validation cases that violate constraints result in:

-Identifying the scope of influence when a change occurs that affects the system architecture

-Improving completeness of validation cases

Challenges

＜Issues that always arise during modeling＞

Ex）
Model：Several thousands of pages
→Not possible to review and maintenance

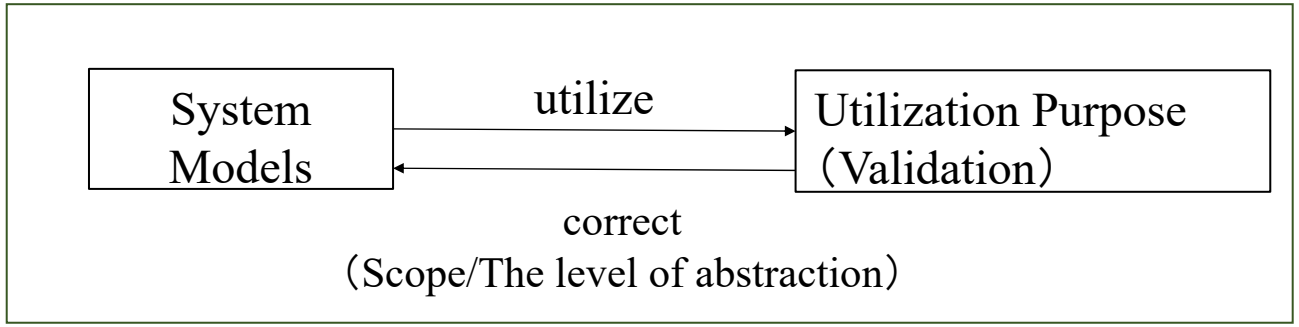
（Challenges）		（Modeling Results）
Ex）Descriptions such as SysML is precedented Ex）Modeling is the objectives. Ex）What a modeler knows is modeled.	Modeling scope is not determined	- Not usable and manageable for a huge amount of information.
	The level of abstraction for modeling is not determined	- Lack of necessary information

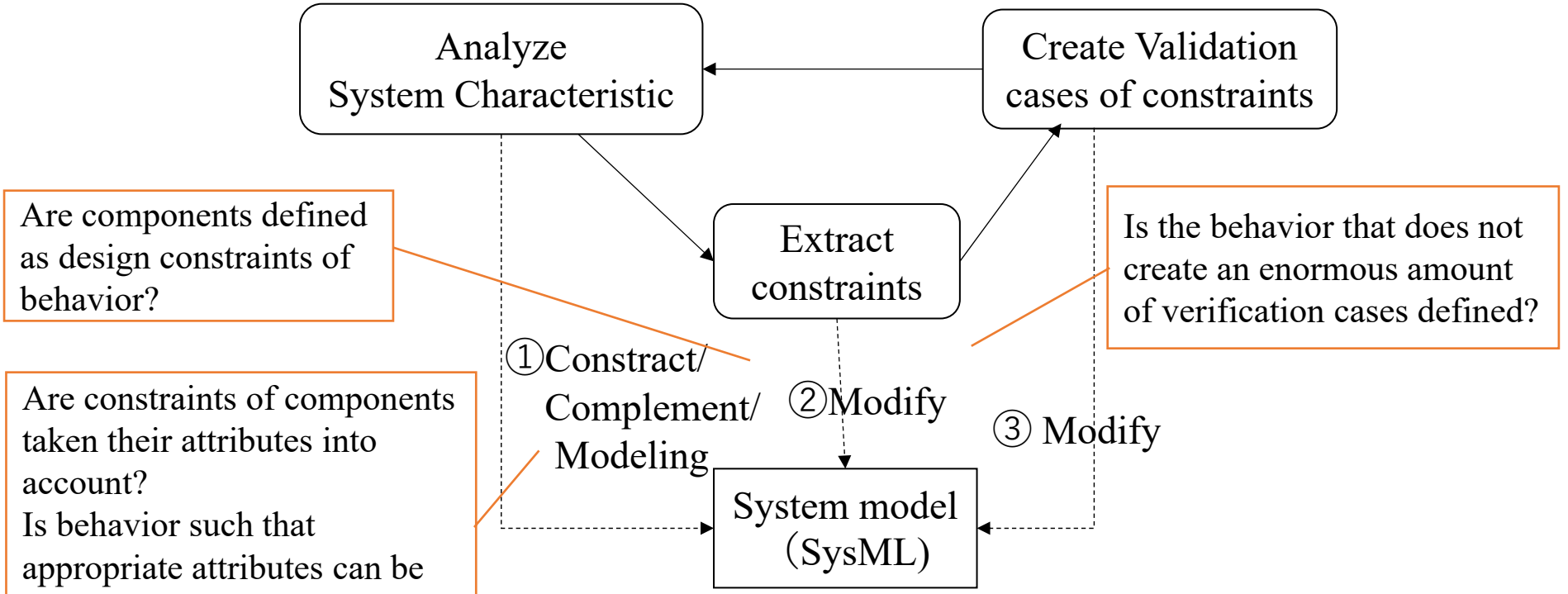
＜Main factor＞
Lack of utilization purpose

（ Prescriptive information that determines the scope and level of abstraction to be model ）

＜Challenges in using system models＞
Difficult to identify the scope of influence when a change occurs that affects the system architecture

Approach





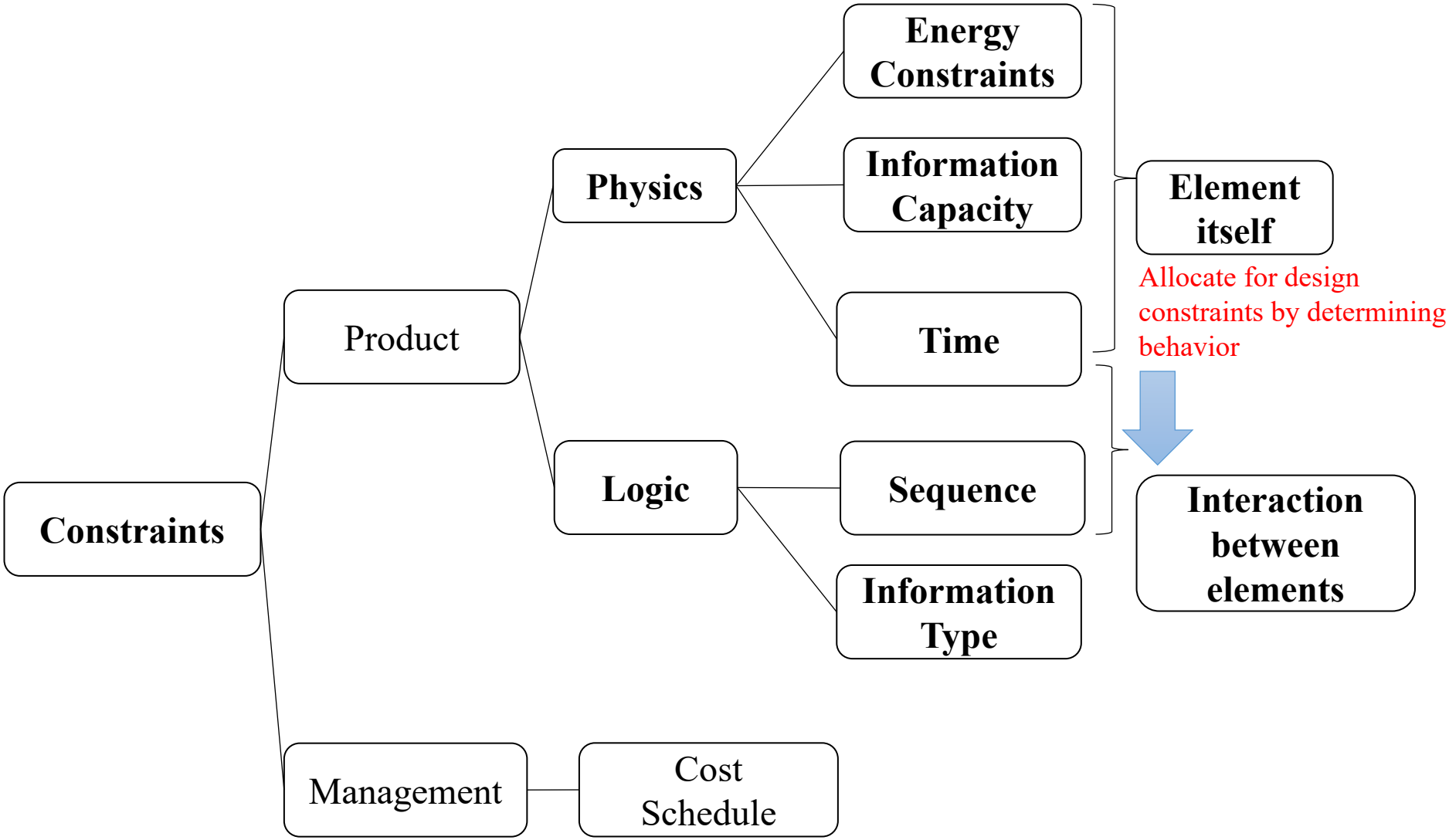
Constraint Definition by Requirement Engineering

Invariant	This is a constraint that “must always be true”.
Type	This is a constraint that “must always be true”.
Precondition	This is a constraint that must be satisfied before something can happen.
Postcondition	This constraint is complementary to preconditions and must be satisfied after something happened.

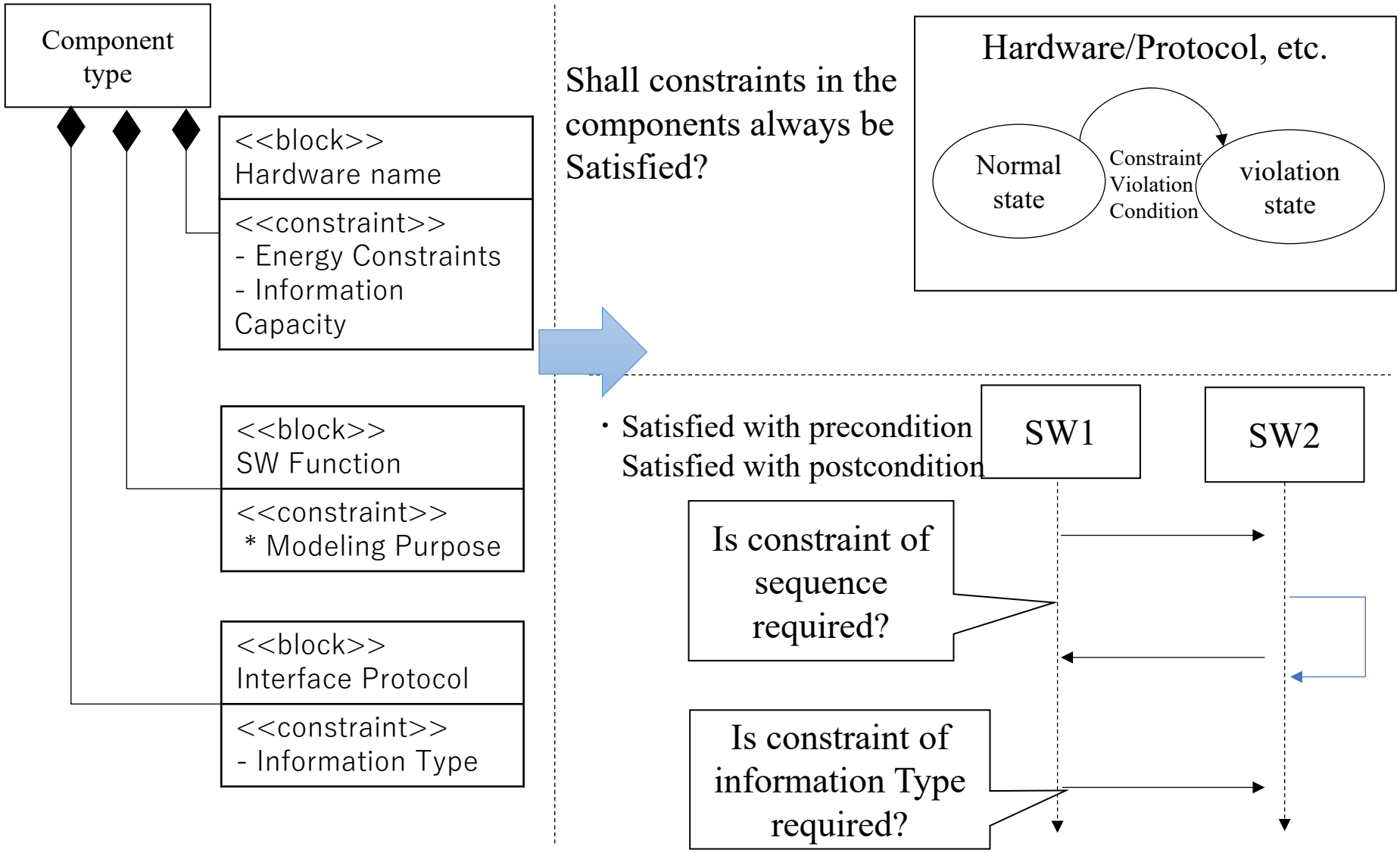
Target

Source： https://re-magazine.ireb.org/articles/modeling-requirements-with-constraints

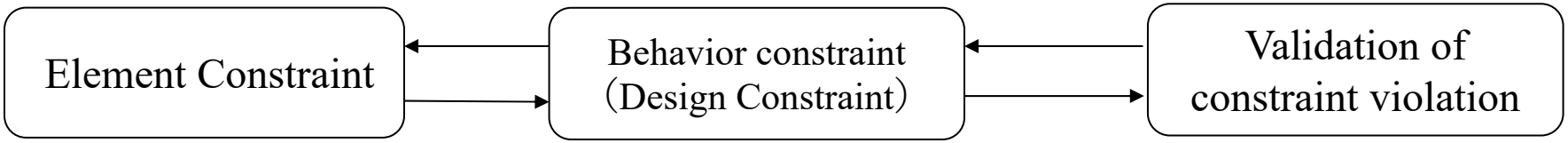
Constraint Types



Transforming constraint from component to behavior

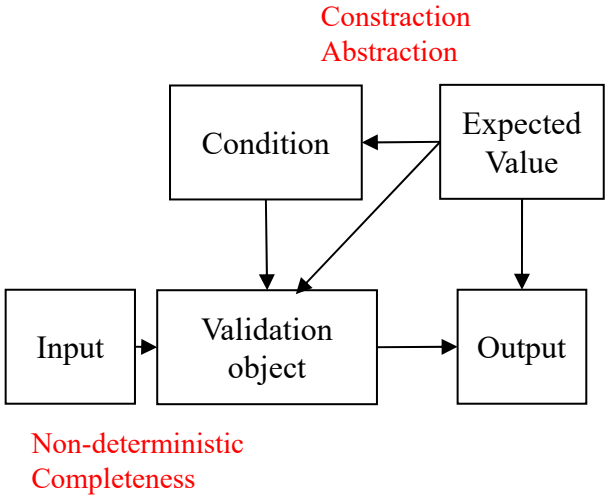


Transforming constraint from components to behavior

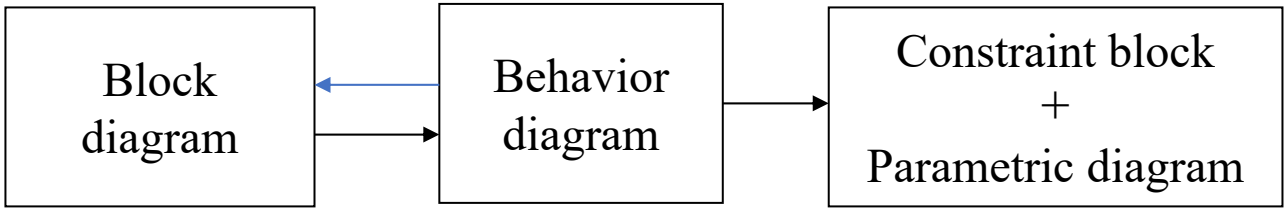


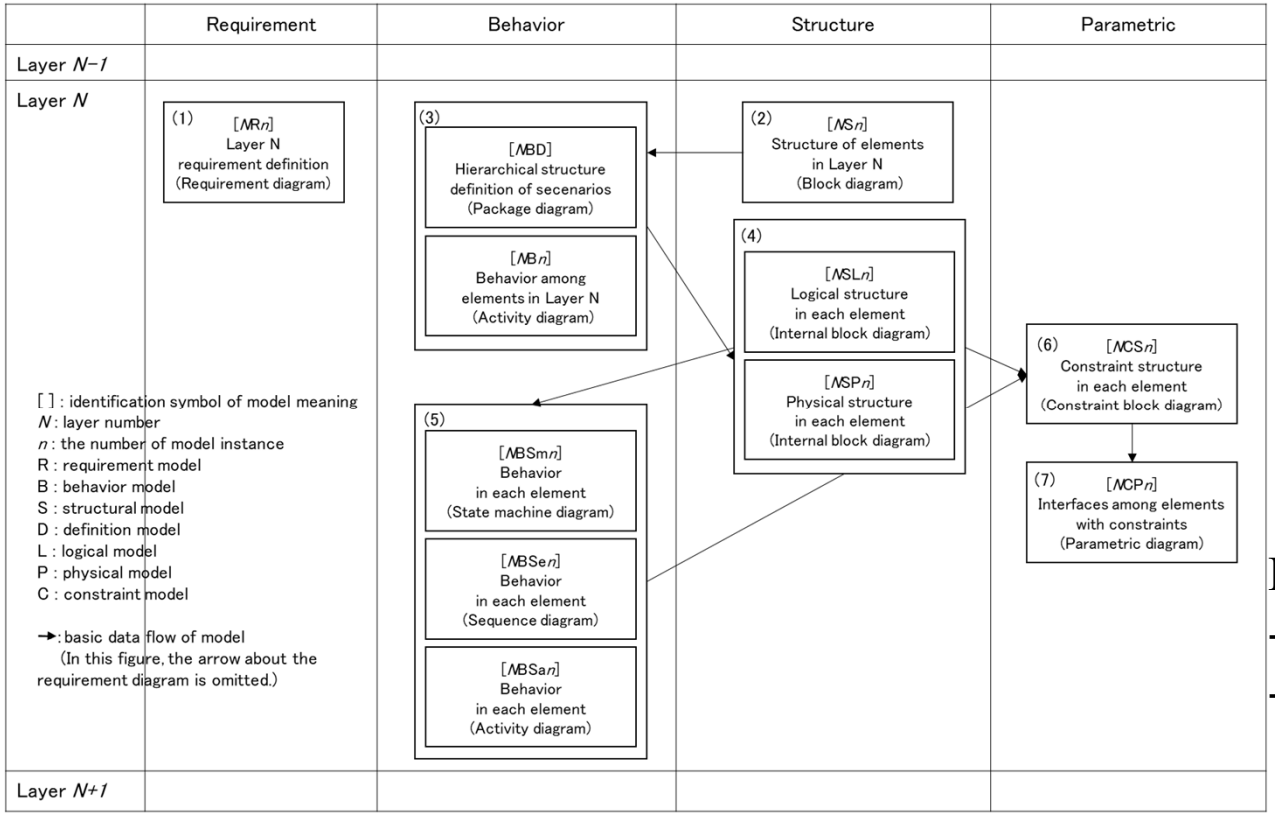
Classification		Constraint Classification
Logic	Type	Information type・Unit
Physics	Time	Operating cycle
		Operating deadline
	Space	Location・Size
		A mount of information
	Energy	Heat
		Power
		Acceleration
		vibration
		Fuel

Class	Behavior constraint	
Time	Required time	
Space	HW operation	Sequence
		Denial
Information	Information handling	Sequence
		Denial



Creating relationship pattern between diagrams



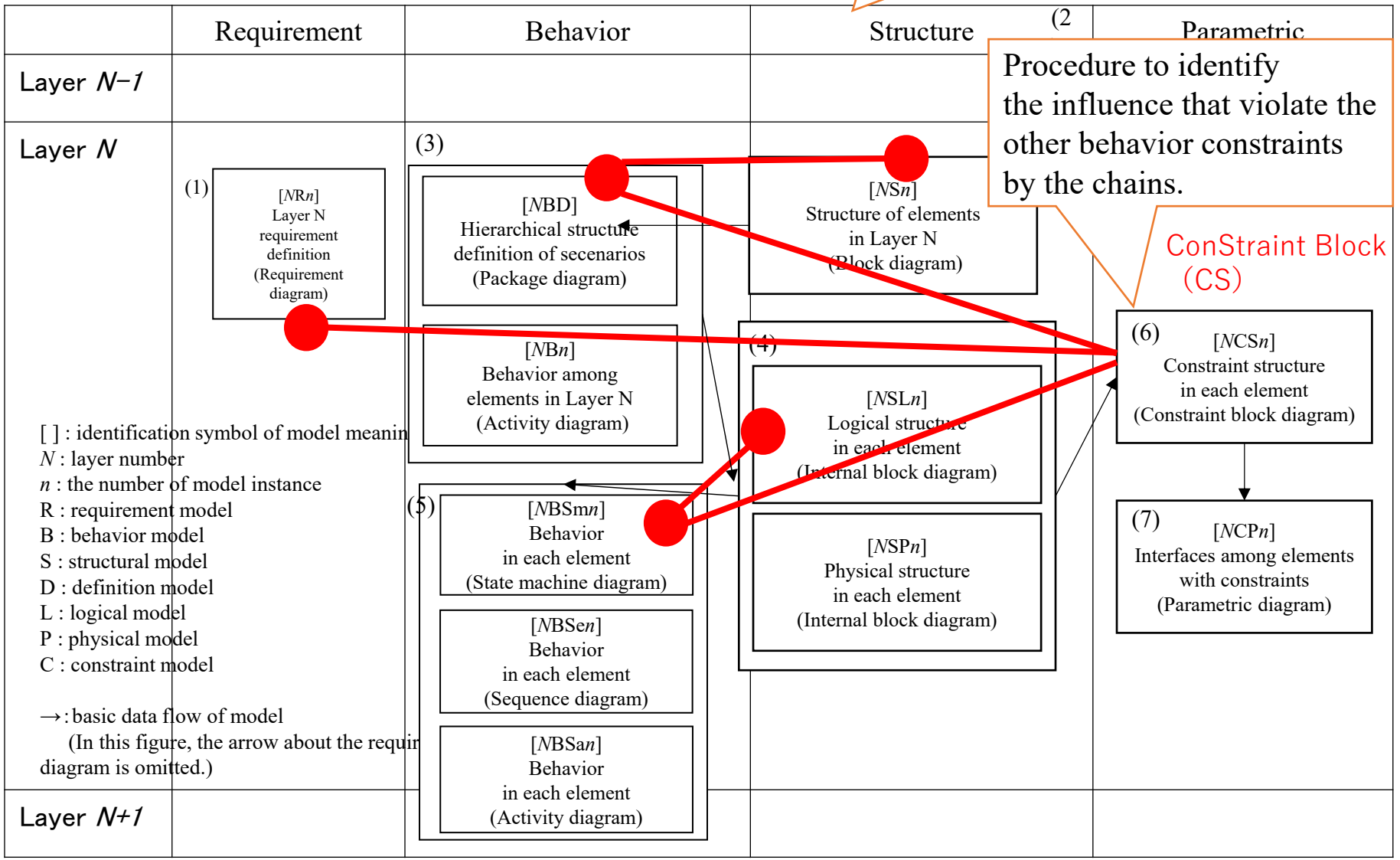


Example:
Generating chain
by relationship pattern

Internal behavior（nBS）
-Internal Component（nSL）
-External Behavior（nB）

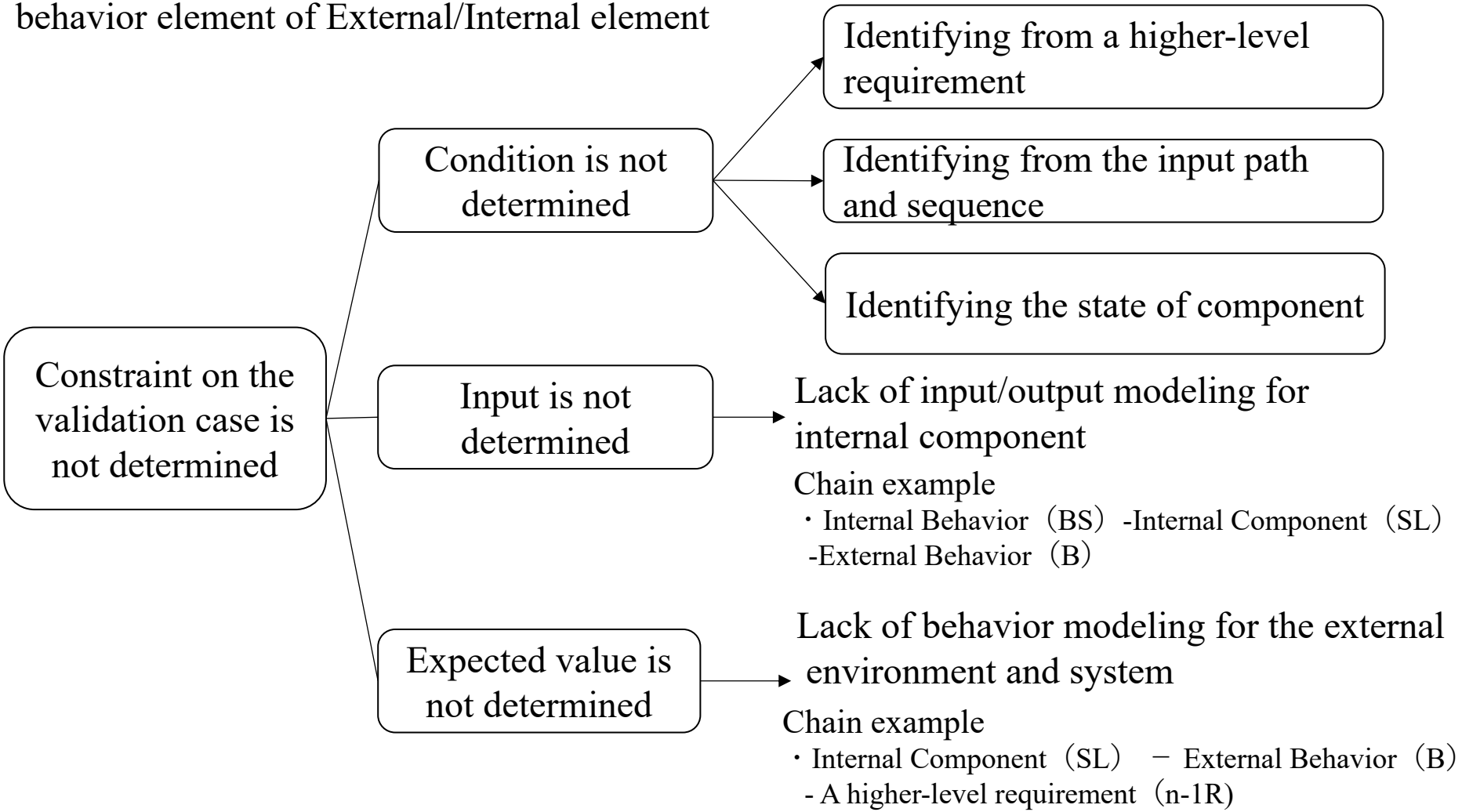
Internal Component（nSL）
-External behavior（nB）
-Higher-level requirement(n-1R)

Change a component
(including a property)



Approach to correct System model

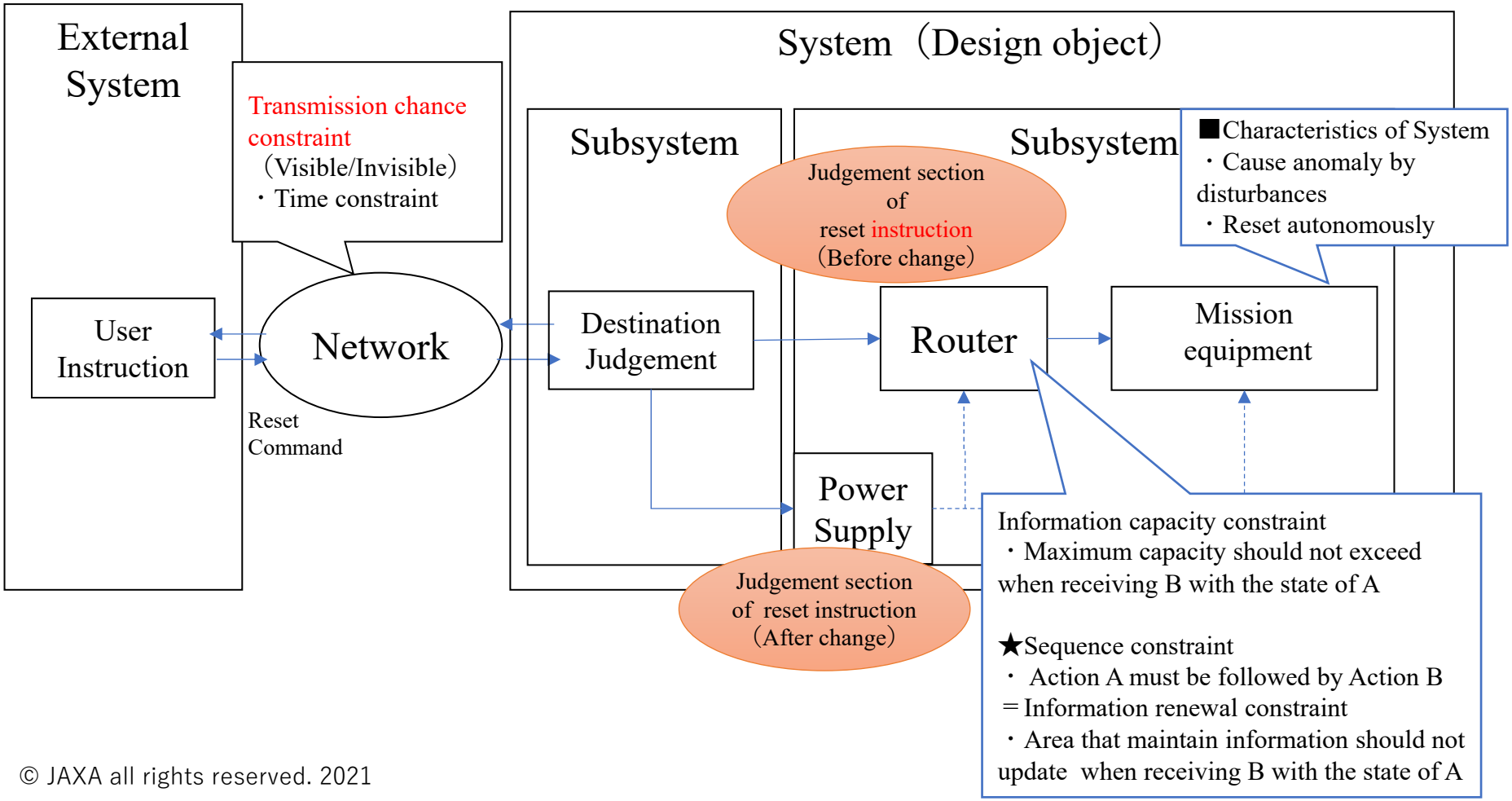
Not appropriate
behavior element of External/Internal element



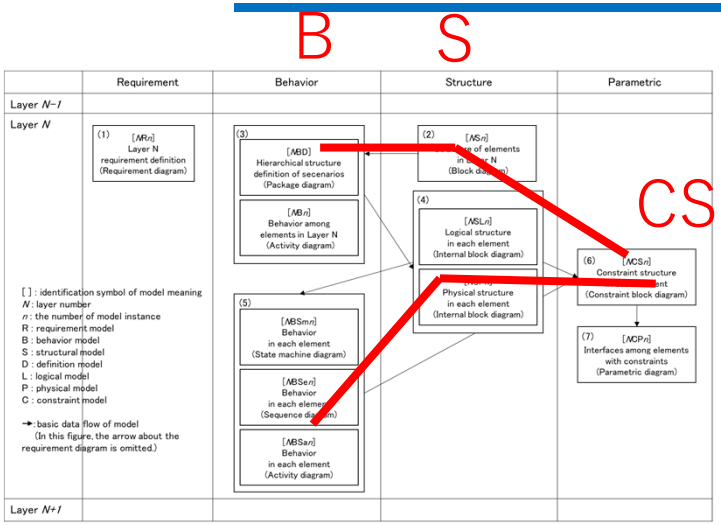
Validation for Proposed Method

■Theme ：Architecture change of digital equipment

・Change both the transmission section of system restart and subsequent measures



Examples of constraints to identify influence

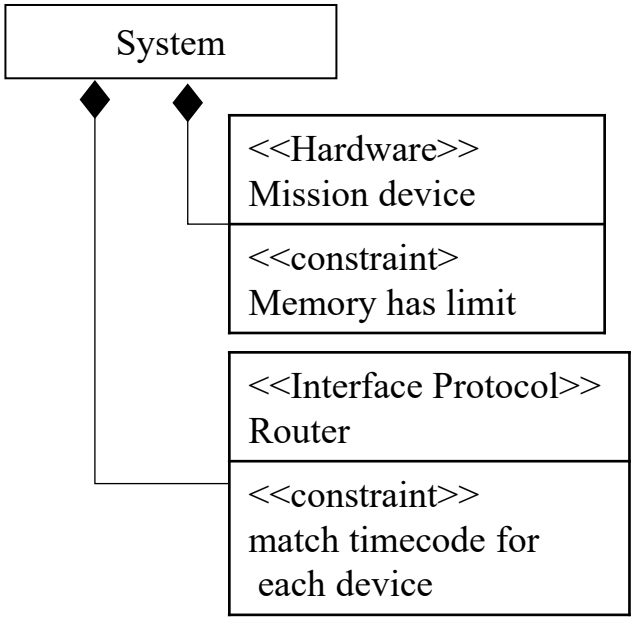


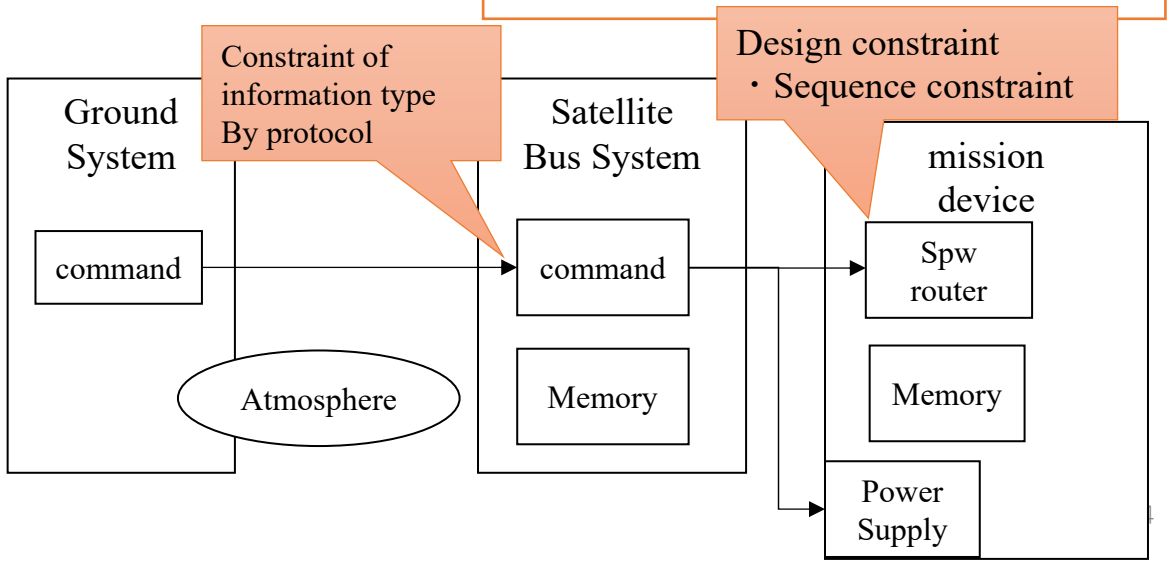
1: Identify critical scenario from external behavior as deviation states
（Structure－Behavior－ConStraint）

Ex: Switching to non-visible operations as outside ground station.

2: Identify constraints from the physical element, and the behavior that violates the constraints.
(Structure Physical－Internal Behavior－ConStraint)

Ex: Commands may be rejected due to memory limit.





Validation Condition for Proposal Method

■Evaluation Index：

Index 1：Can impact on design caused by a change be identified ?

Index2： Will time spent creating a validation case be streamlined?

■Experimenter

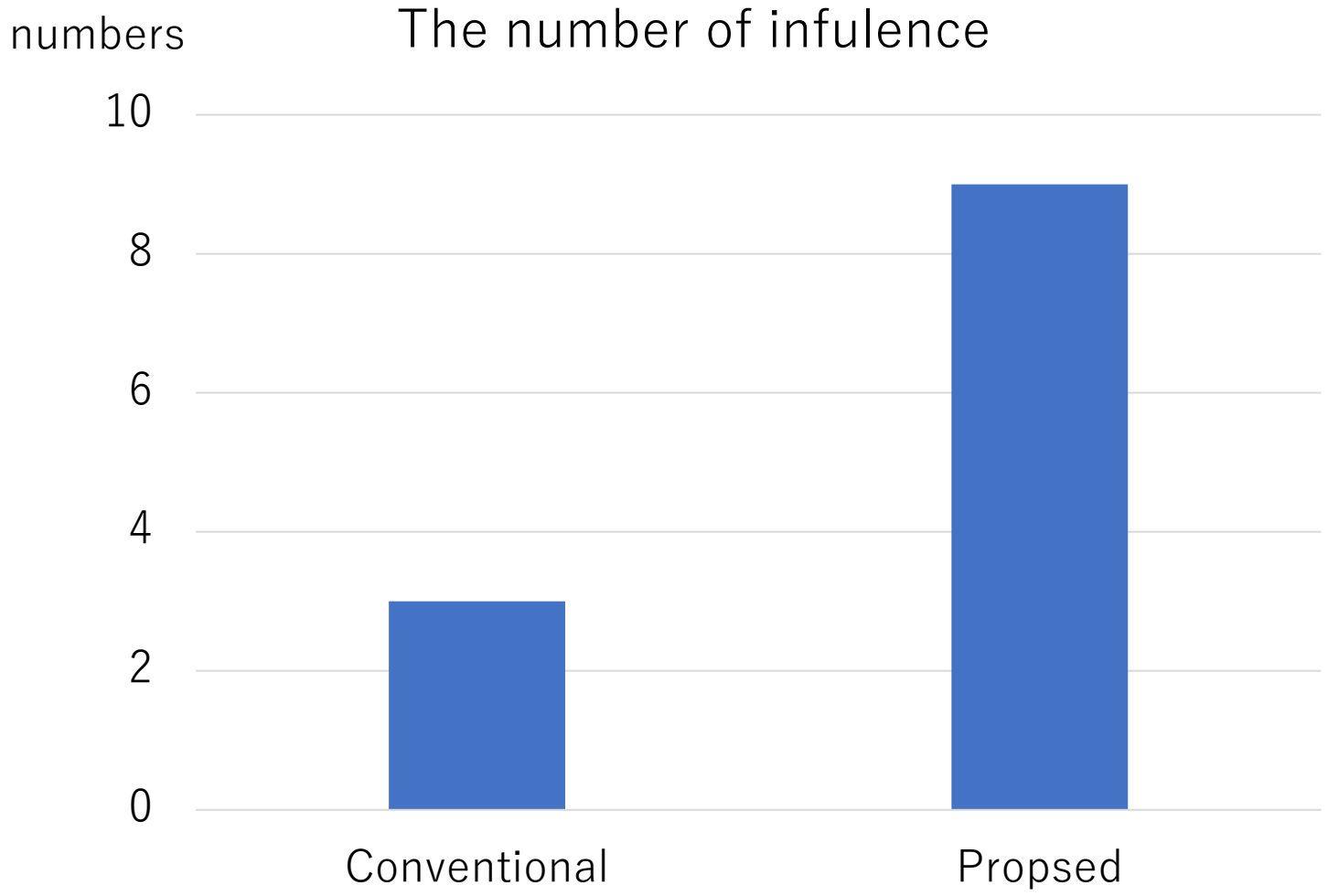
Two engineers with comparable experience .

■Experimental procedure (two topic)

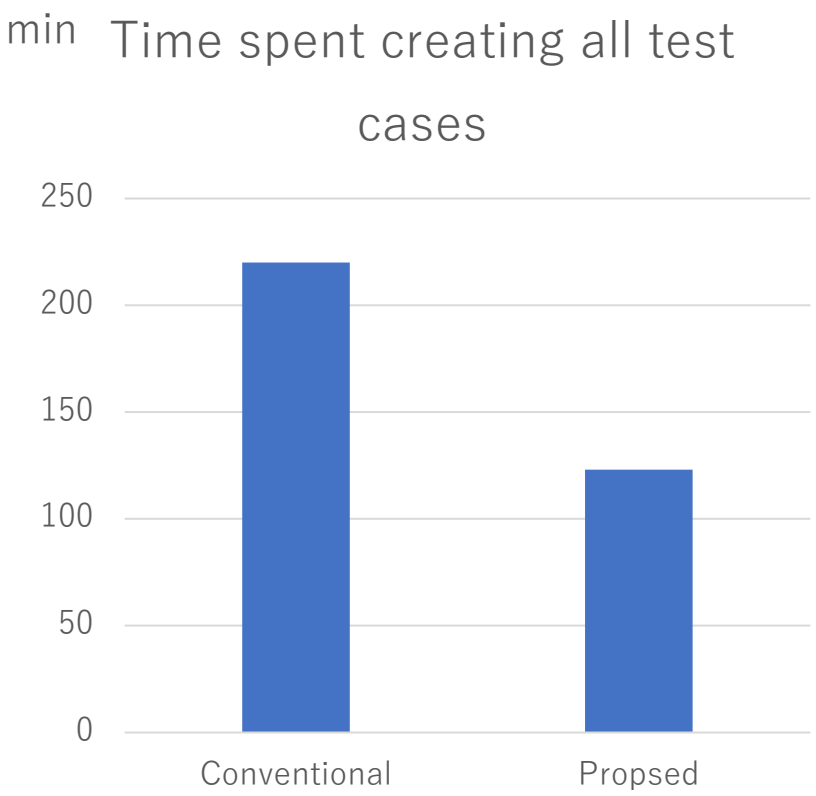
1 ：Analyzing influence by conventional document-based

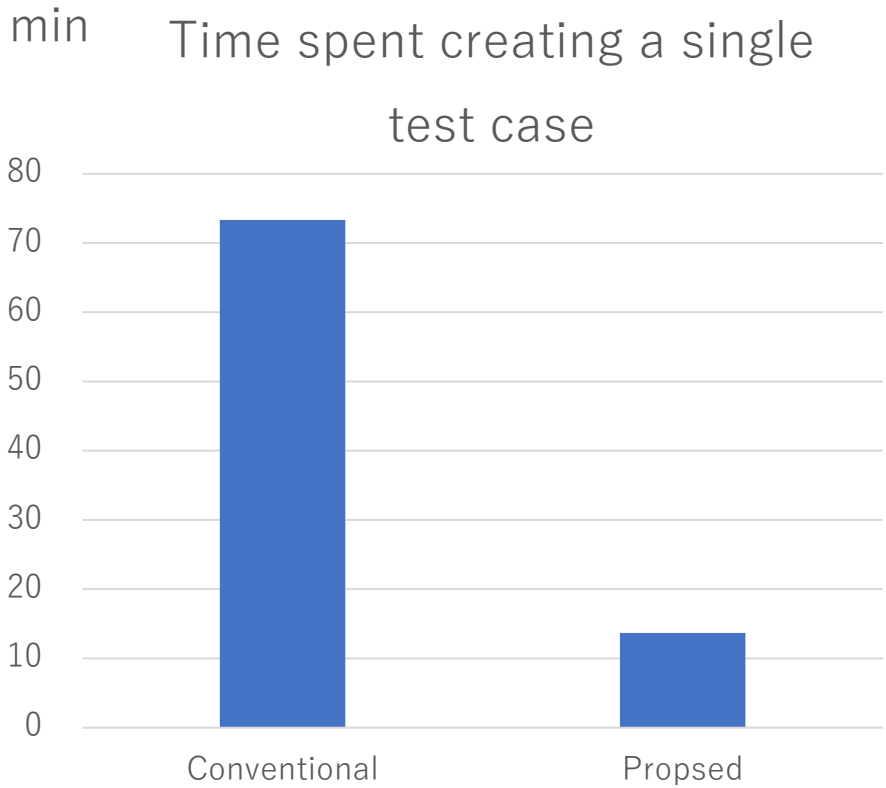
2 ： Analyzing influence by proposed model-based

Evaluation result (index 1)



Evaluation result (index 2)





MBSE will be more efficient.

Discussion

- Is it useful to specify influences of architecture change by extracting behavior constraints ?
  - Appropriate modeling for objectives
  - The number of validation case
  - Architecture complexity

- How can multiple behavior constraints be extracted?
  - Control flow
  - Parameter constraint
  - External feedback

Conclusion

■Issue

Identifying the scope of influence depended on “experience” and “intuition” of modelers in case of a change that affected the system architecture

■Proposal

・Modeling focus on transform from element to behavior constraint.
・Improving the completeness of influence when system architecture changes by chain of external and internal behavior.

■Conclusion

- Our method can effectively identify the scope of influence that violates behavior constraint.

- Decreasing in occasions to depend on “experience” and “intuition” of modelers

Thank you for your attention !