Customer Needs Elicitation Method for Business Architecture Design in the Space Industry

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Hiroki Umeda

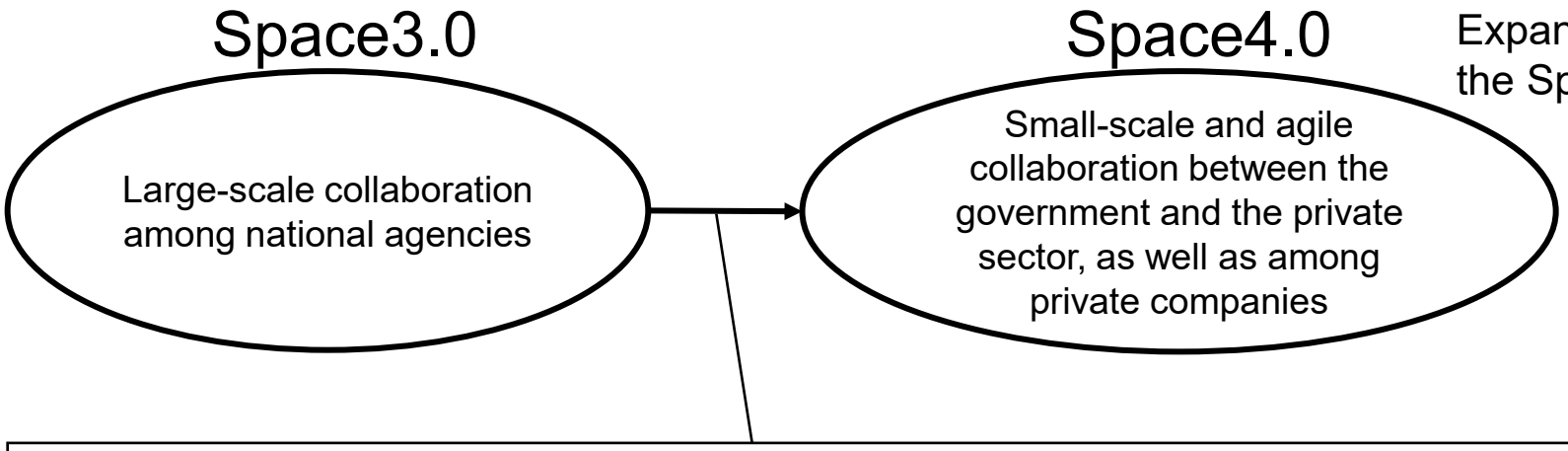
R&D Directorate

Japan Aerospace Exploration Agency

Outline

- Background and challenges
- Proposed methods
- Effectiveness evaluation
- Discussion

Space industry in Japan



Issue 1 : Space systems have limited capabilities due to numerous constraints
→ Create a service designed for specific customers

Issue 2 : Few experts possess knowledge in both business and systems
→ Provide support through SE and MBSE

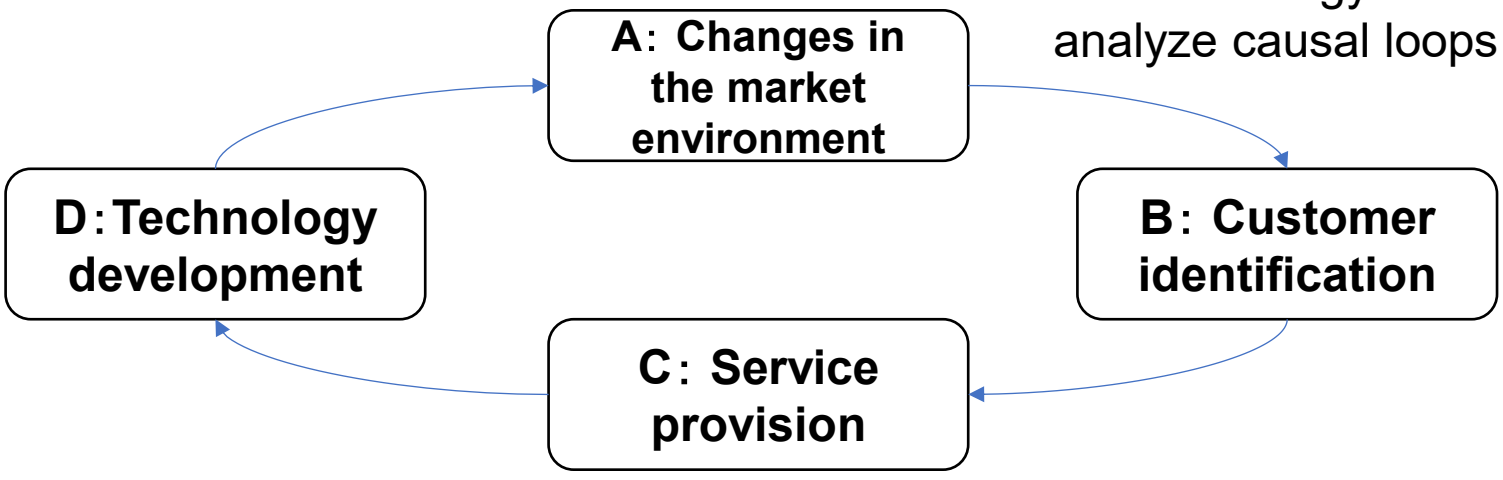
Services using spacecraft for customers in other industries
- Communication, Broadcasting, Positioning
- Monitoring using Earth observation satellites, such as risk assessment
- Hardware demonstration, experiments, and entertainment in the space environment

"**Small-scale, rapid collaboration**" drives "**growth and changes**" in the space industry
Business architecture design needs to meet the following key points:

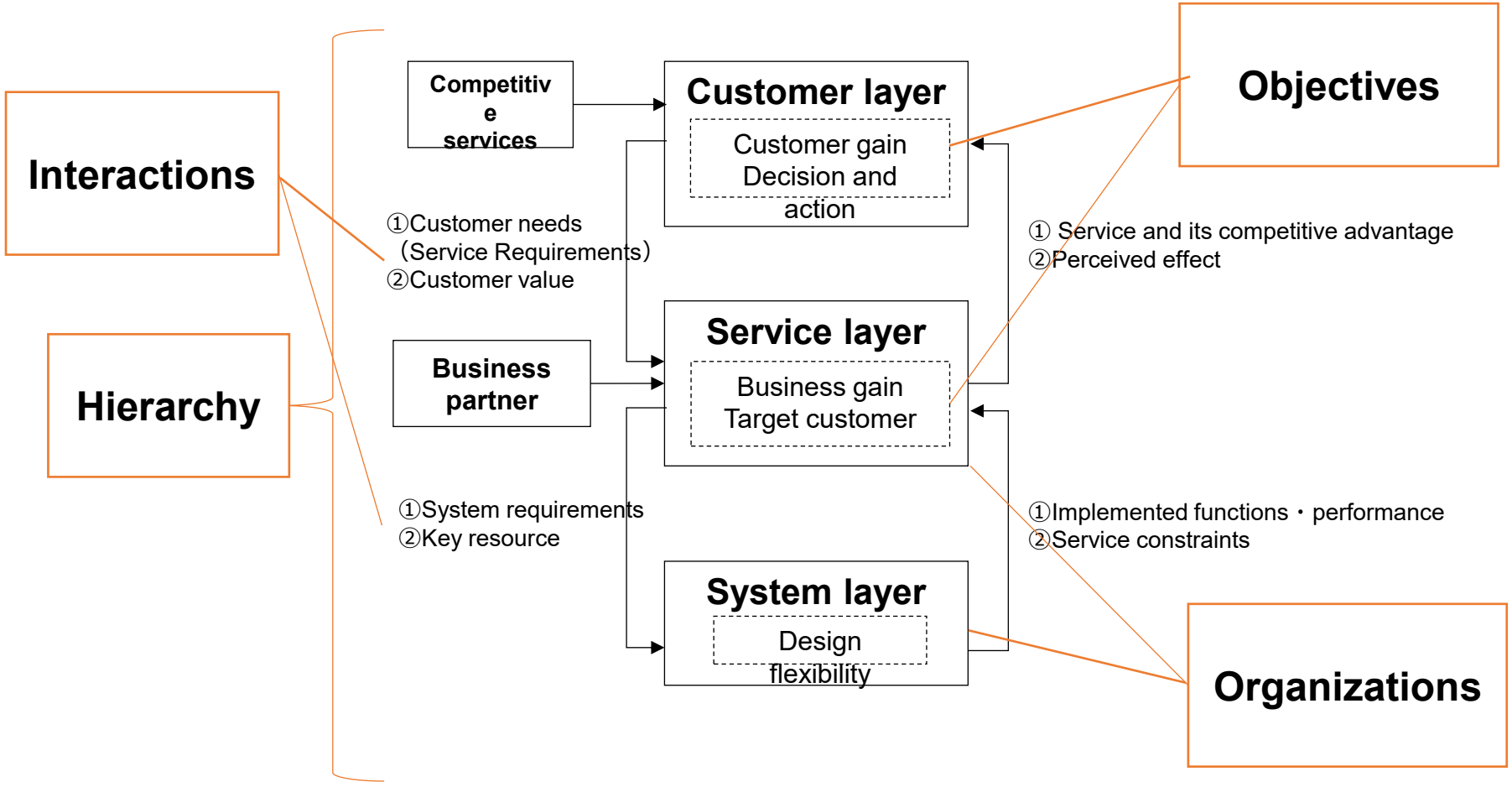
A-B: Identify the target customer amid changes in the market and its environmental conditions
B-C: Identify key resources to ensure customer-perceived service advantages

C-D: Identify technological development targets to ensure service advantages for customers

A methodology is needed to analyze causal loops

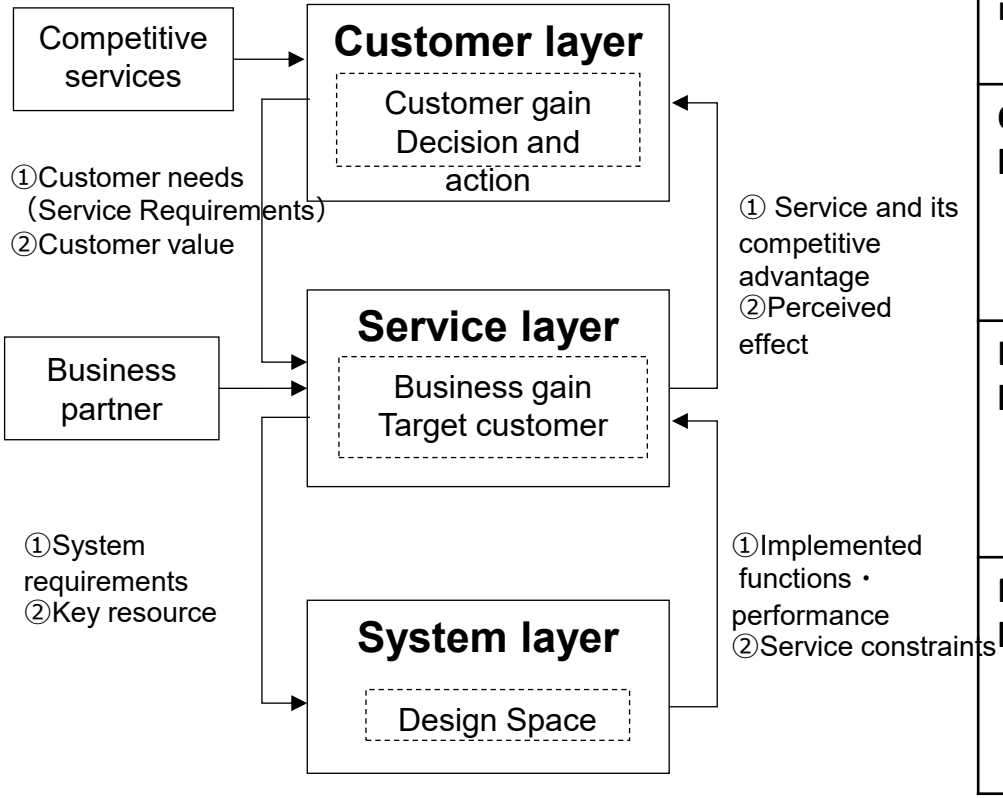


Applying “system characteristics such as objectives, organizations, interactions, and hierarchy” to the business layer in systems engineering



Proposed method

Given the limited SE/MBSE expertise at the business layer,
the method defines the architecture framework into three layers: objective, logical and physical

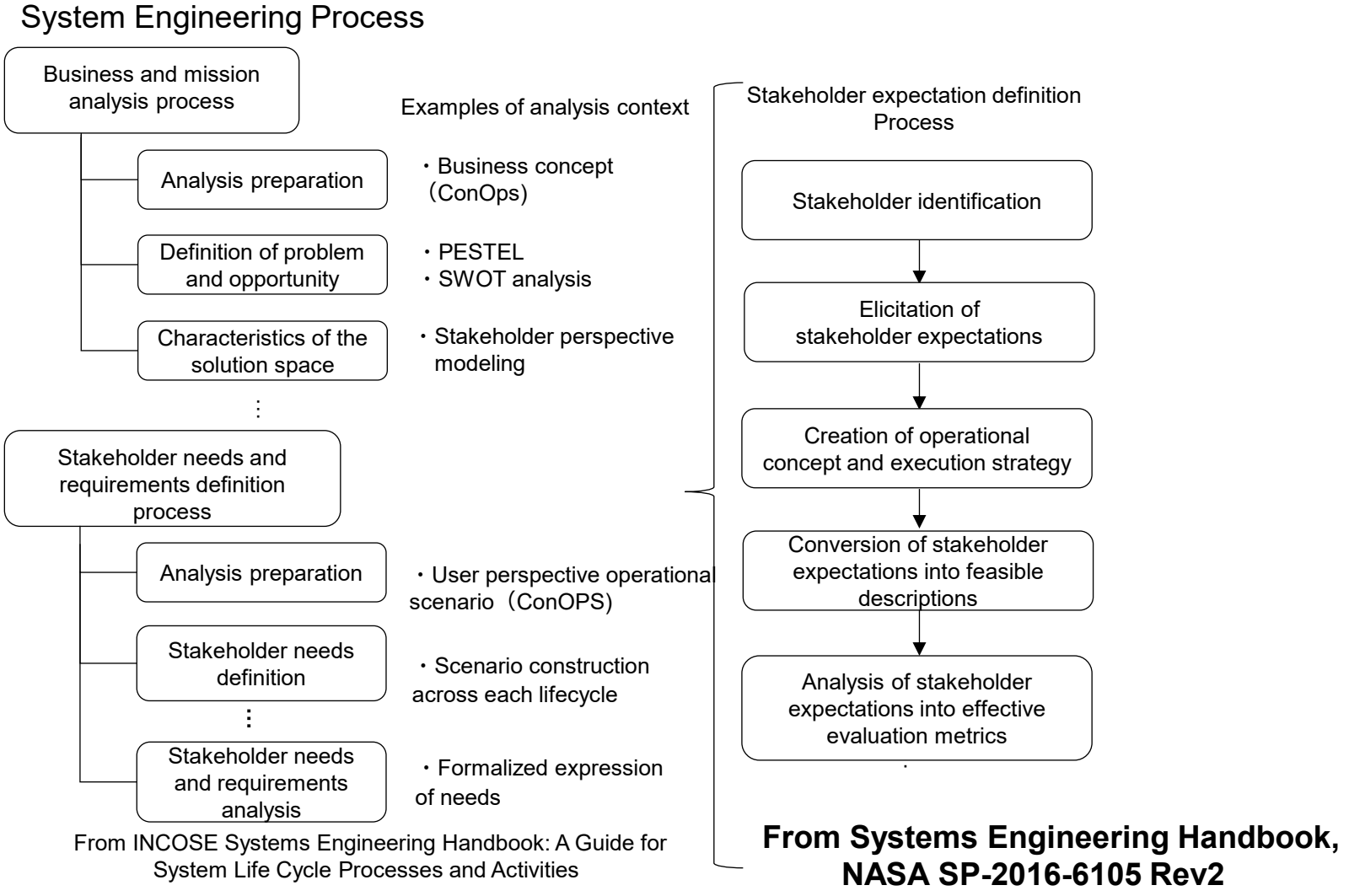


アーキテクチャフレームワーク

Classification	Target	Requirement	Behavior	Structure
Objective layer	Customer business	Scope of this paper		
Logical layer	Service			
Physical layer	System			

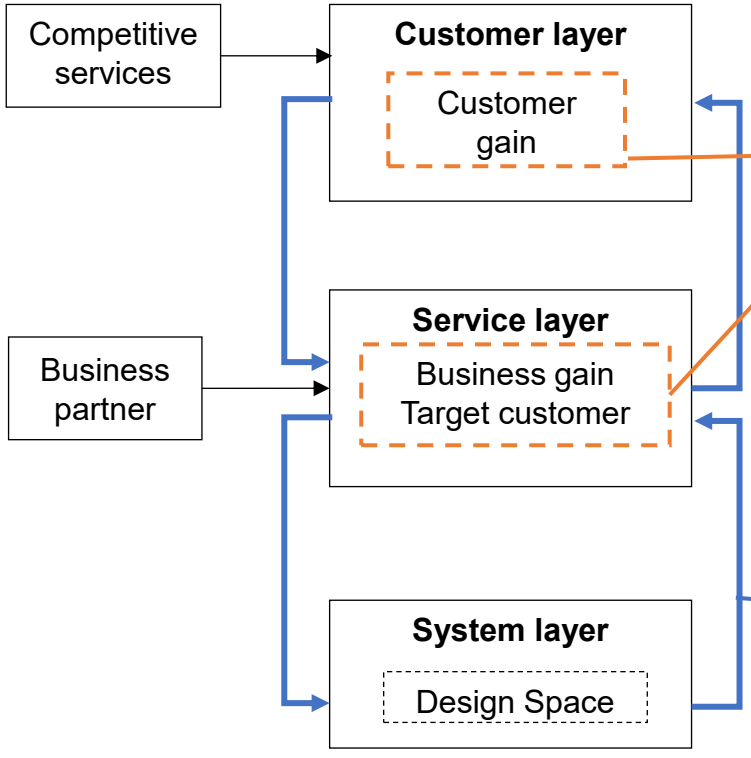
Business analysis in the SE process

Stakeholder analysis is important



Expected effects of applying SE･MBSE to the BA

The following effect are expected from SE characteristics in designing business architecture for the space industry



＜SE characteristic1＞
Definition of “success” based on “the objective”

＜Expected effect＞
Identification of the target customers with competitive advantages

＜SE characteristic 2＞
Overall integration using the lifecycle

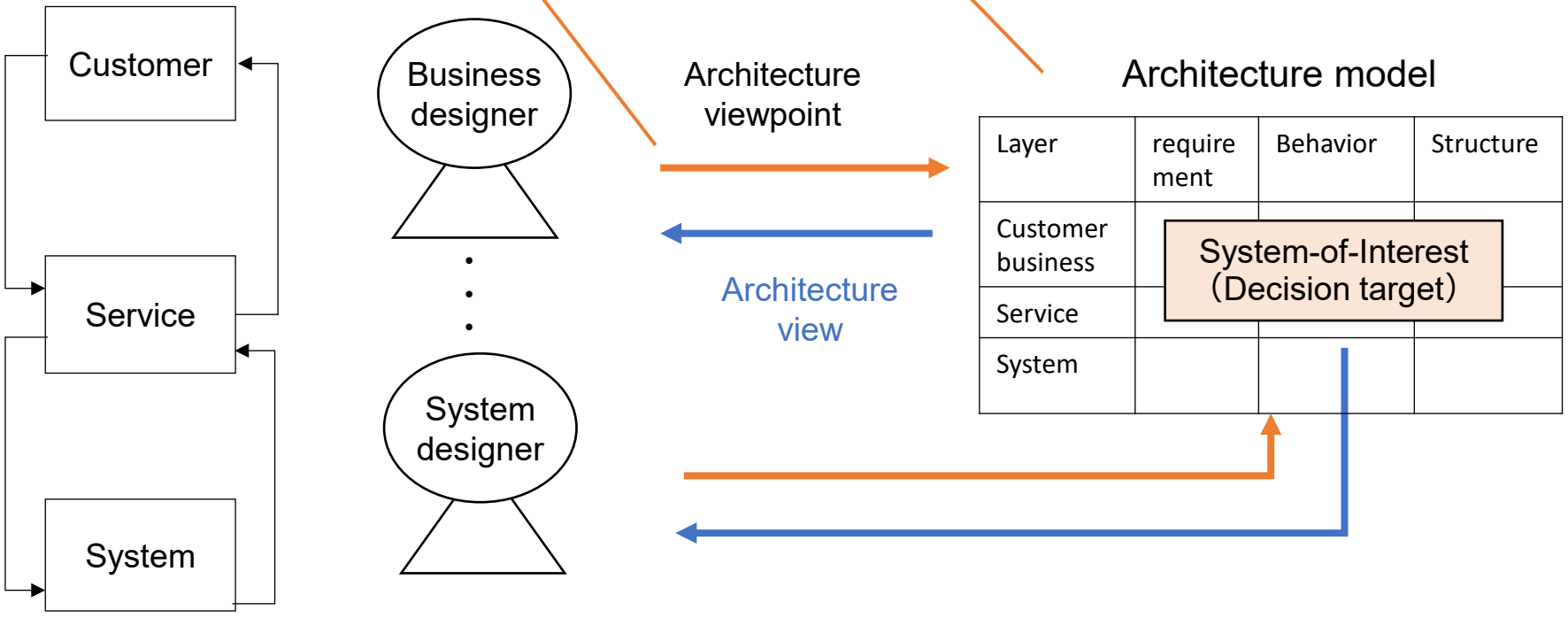
＜Expected effect＞
Continuous development of customers and services, such as technology development

Expected effects of applying SE･MBSE to the BA

The following effects are expected for business architecture in the space industry based on MBSE characteristics

＜MBSE characteristic1＞
Integration of various expert information from different viewpoints
＜Expected effect＞
Marketing Management, Integration of requirement engineering

＜MBSE characteristic1＞
Managing complexity through information consistency
＜Expected effect＞
Reflecting changes in the market environment, customer identification, and technology development can be pursued in parallel



Overview of Software Requirement Engineering Method

A systematic set of activities and technologies to capture, define, and manage customer and stakeholder needs as system requirements

【Category 1】
Domain decomposition

【Category 2】
Scenario

【Category 3】
Goal-oriented

【Category 4】
Brainstorming

CLOSED

OPEN

STATIC

DYNAMIC

Domain decomposition
OOA
JSD

Problem frame

(SysML) Internal Block Diagram

(SysML) Block Definition Diagram

(SysML) Activity Diagram

(SysML) Sequence Diagram

MSC

Use case

Scenario

Storytelling

Cognitive techniques

Logical thinking

Abduction

Prototyping

Goal
KAOS
GBRAM
GSN

i*
(iSTAR)

KJ Method

Role play

Brainstorming

SSM

Etymology
Contextual Techniques

Marketing Management for SE

A comprehensive process to systematically implement marketing activities, enabling companies and organizations to meet customer needs and achieve their own goals

Analysis process

A: External environment analysis
（Competitive environment, Customer persona definition）

1：Hypothesis of business structure
2：Design of customer needs exploration
3：Customer interviews

B: Internal environment analysis
（Key resource identification）

1：Solution development
2：Business structure design

C：Competitive Comparison Analysis
（Clarification of positioning）

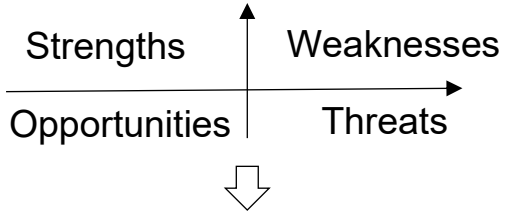
1：Business Trade-off
2：Target customer

D: Competitive strategy planning

1：Definition of service requirements
2：Conversion to system requirements

Analytical Framework Overview

SWOT analysis



Business model canvas

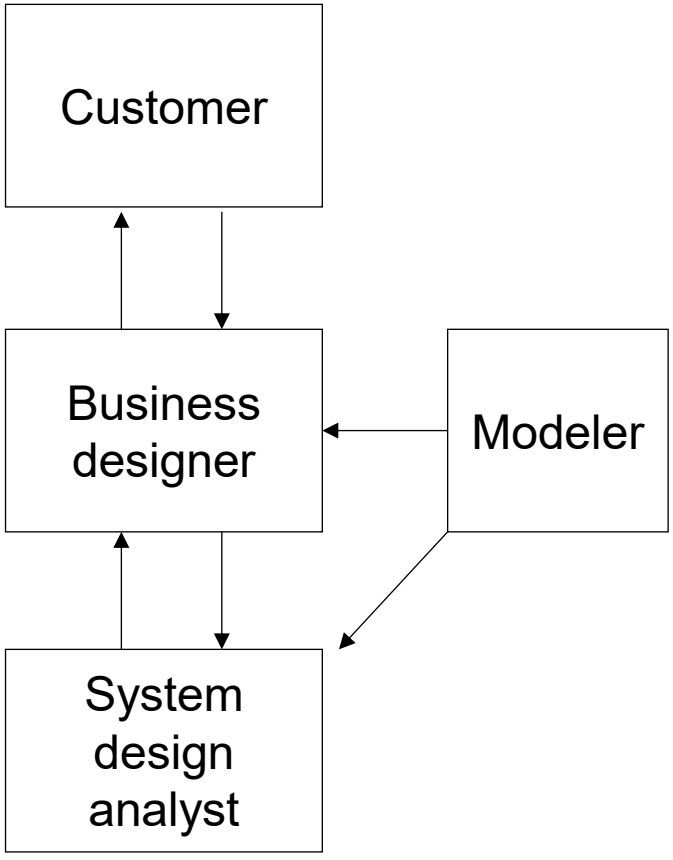
Partner	Activity	Value Proposition	Customer Relationship	Customer segment
	Recourses		channel	

Customer Segmentation

- Industrial classification
  - ・Urban planning
  - ・Forestry
  - ・Agriculture
  - ・・・・
- Business classification
  - ・Data sales
  - ・Image analysis
  - …
- Specification
  - ・Resolution
  - ・Bandwidth
  - ・Satellite counts（Observation frequency）

Proposed method

The proposed method enables proposal-driven modeling due to the limited resources of business designers



Overall process

A： Analysis of existing business and services

B： Analysis of new business and services

C： Decision making for business and services, identifying flexibility and challenges

D： Modeling of business architecture

E： Utilization of business architecture models

Overview of the proposed method

Systems engineering process

① Business structure analysis

② Definition of problem and opportunity

③ Characteristics of the solution space

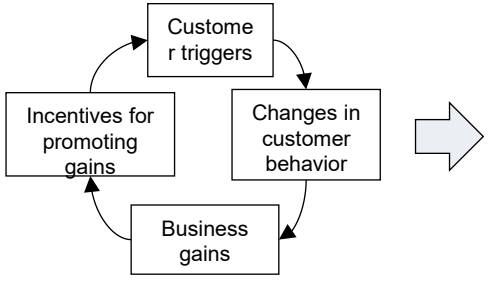
④ Stakeholder identification

⑤ Elicitation of stakeholder expectations

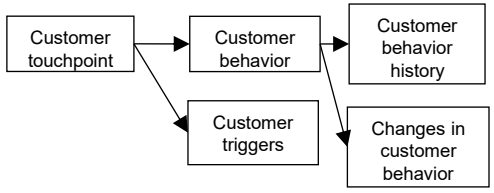
⑥ Conversion of stakeholder expectations into feasible descriptions

Outline of an analysis framework

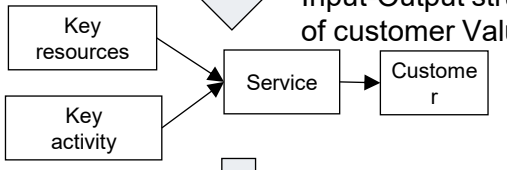
①Business structure analysis through causal loops



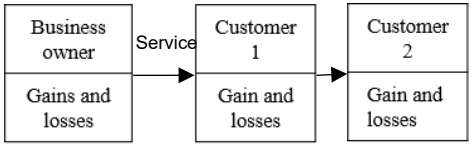
②Scenarios of problems and solutions



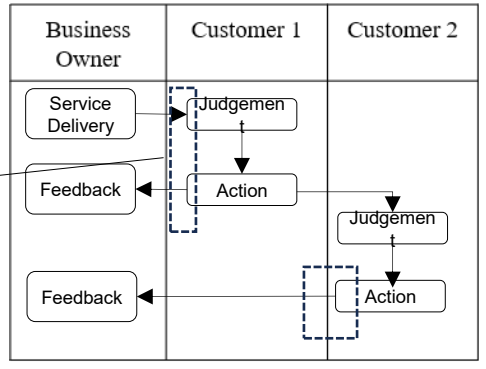
③ (For each scenario) Input-Output structure of customer Value



④Customer segmentation based on gains, losses, and hierarchical structure



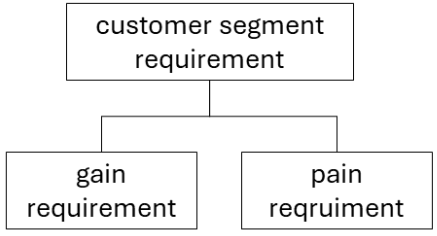
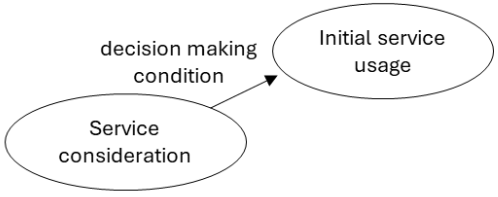
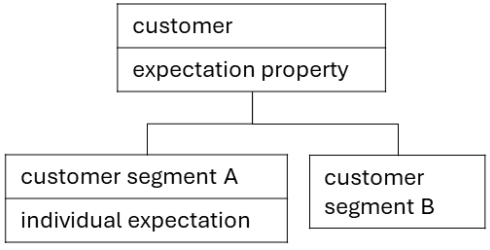
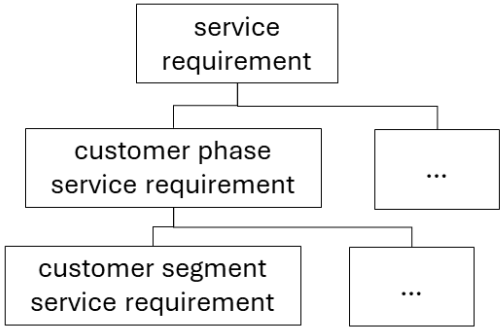
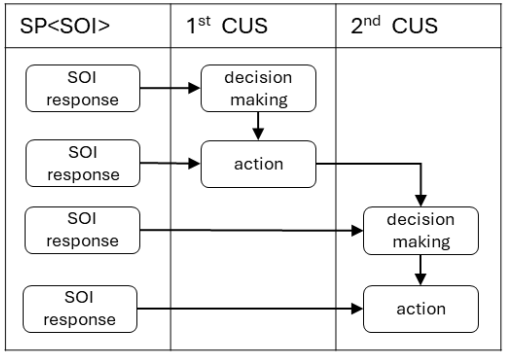
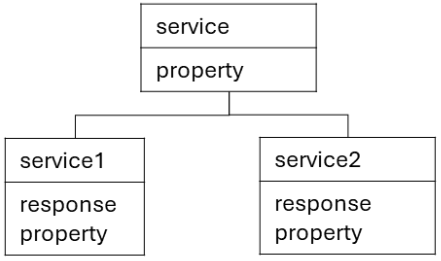
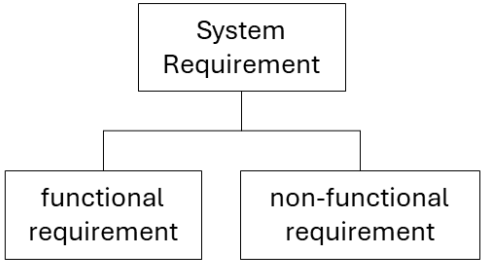
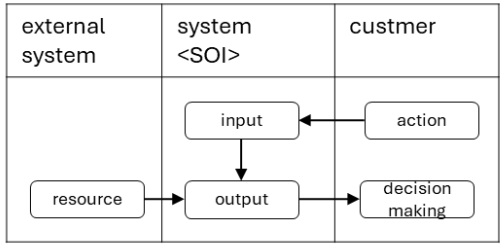
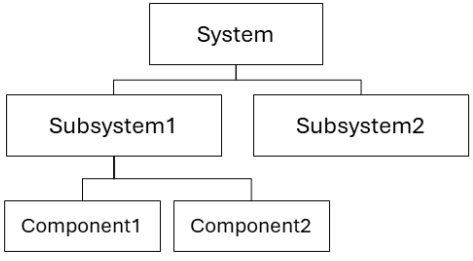
⑤Identification of customer expectations through the analysis of the interaction between customer judgment and behavior



⑥：Extraction of customer needs in a semi-formal representation from the interface with the customer, considering their context

Example： Customers require a system response when the conditions are XX.

Model overview based on the proposed method

	requirement	behavior	structure
customer layer			
service layer			
system layer			

Effect measurement results

The proposed method shows a certain level of effectiveness when existing analytical information is available

Conventional method: CVCA（Customer Value Chain Analysis）

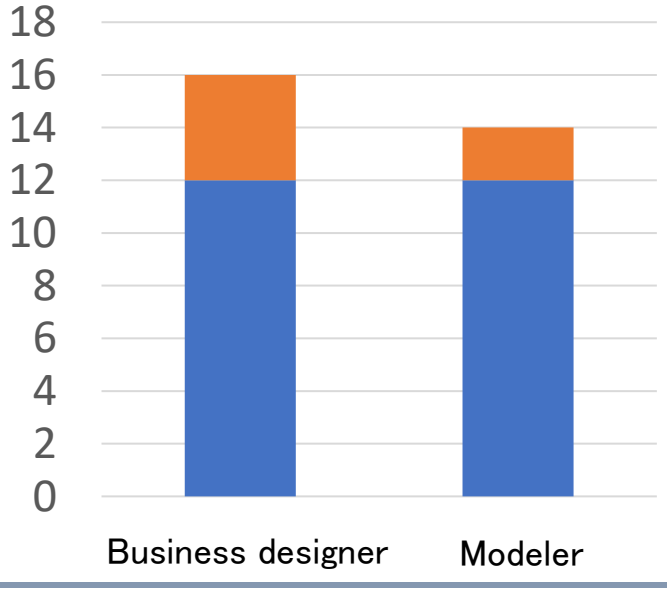
Proposed method : Process 3, which represents the input and output of customer value
Process 4, which represents the hierarchy within the customer chain,

Implementers : Business designer and Modeler without domain knowledge

Measurement method: The proposed method is applied after the conventional method. Increments are measured

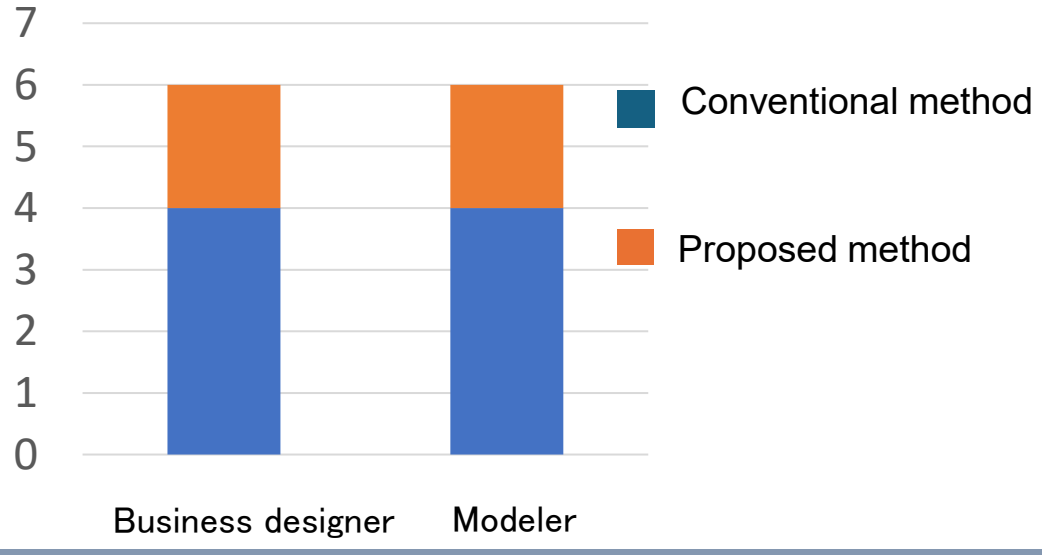
Evaluation Metric 1:

Can new customer needs be elicited?



Evaluation Metric 2:

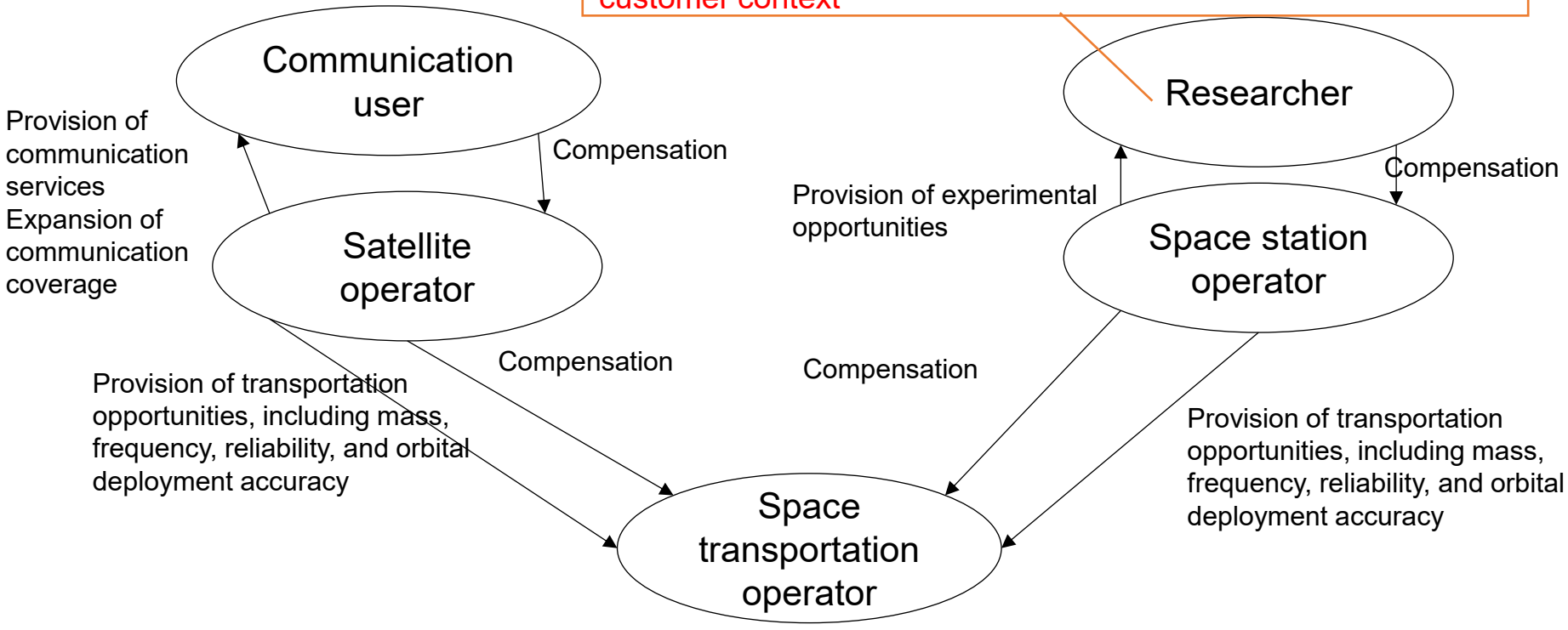
Can the elicited needs be converted into system requirements?



Results of the conventional method

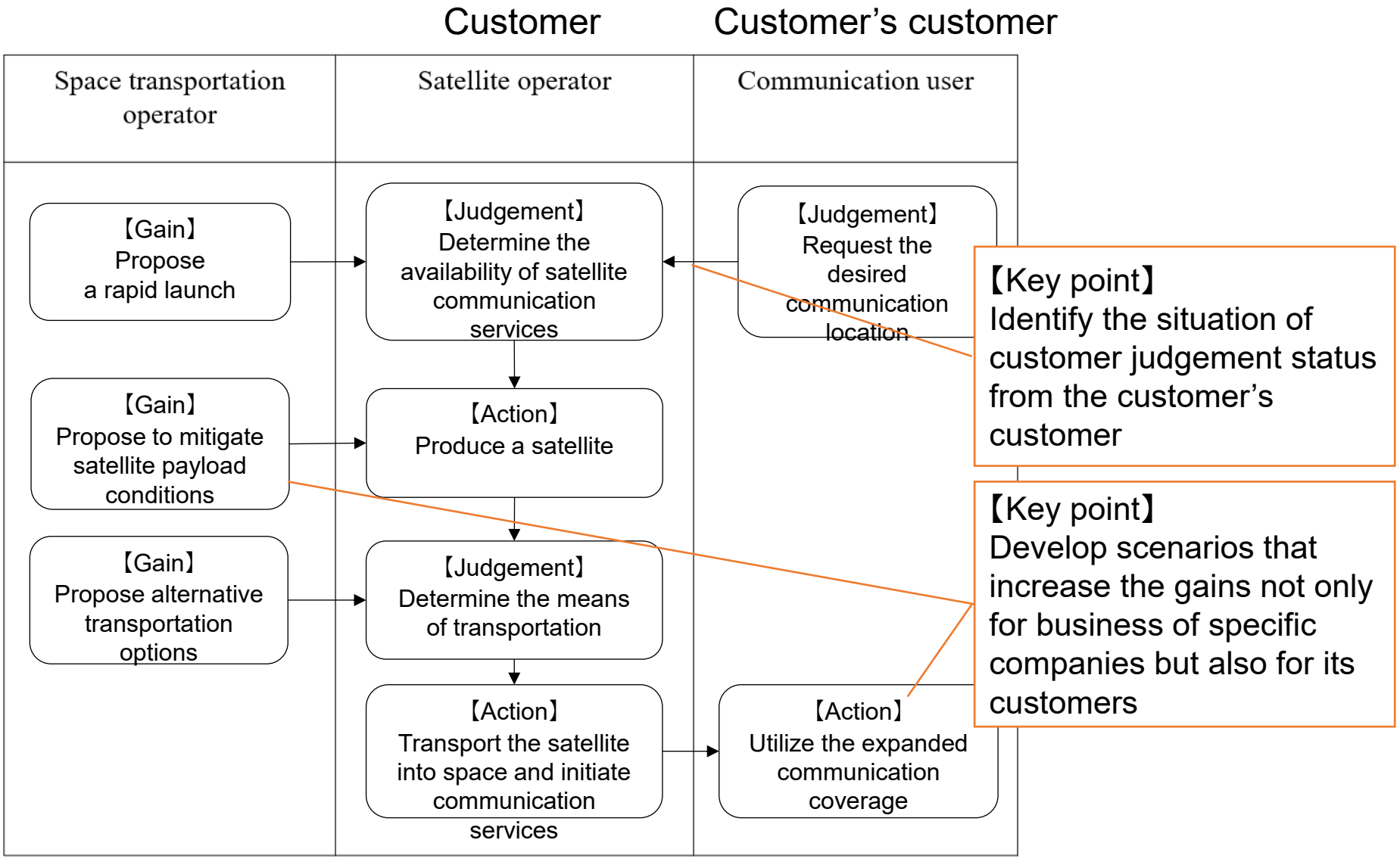
CVCA is a framework for visualizing and analyzing the chain of processes through which customers receive and experience value from a product or service, as well as the stakeholders involved in those processes

【Limitations of the method】
Identifying competitive customer value, which is also referred to as Measure of Effectiveness (MoE), is difficult due to insufficient customer context



Customer Value Chain Analysis

Results of the proposed method



Discussion

Layer Type	Target	Requirement	Behavior	Structure
Objective layer	Customer			
Logical layer	Service			
Physical layer	System			

Scope of this paper

Currently being developed

1: Expanding the layers constructing the method

2: Expanding method users

Enable non-domain users to achieve a certain level of effectiveness with this method through LLM-based support

3: Expanding applicable business domains
Apply to various types of space-related businesses

Conclusion

■Challenge

Issue1：Space systems have limited capabilities due to numerous constraints

→ Create a service designed for specific customers

Issue 2: Few experts possess knowledge in both business and systems

→ Provide support through SE and MBSE

■Proposal

Create architecture models using analysis methods from Software Requirements Engineering and Marketing Management

■Conclusion

The proposed method can elicit customer needs that the conventional CVCA method cannot

- Identify customer context by dividing customer judgement and actions
- Customer judgements elicit competitive advantages against rival services and enable determining target customers
- Customer actions lead to the identification of customer gains and enable the setting of Measure of Effectiveness (MoE)

Thank you for your attention !