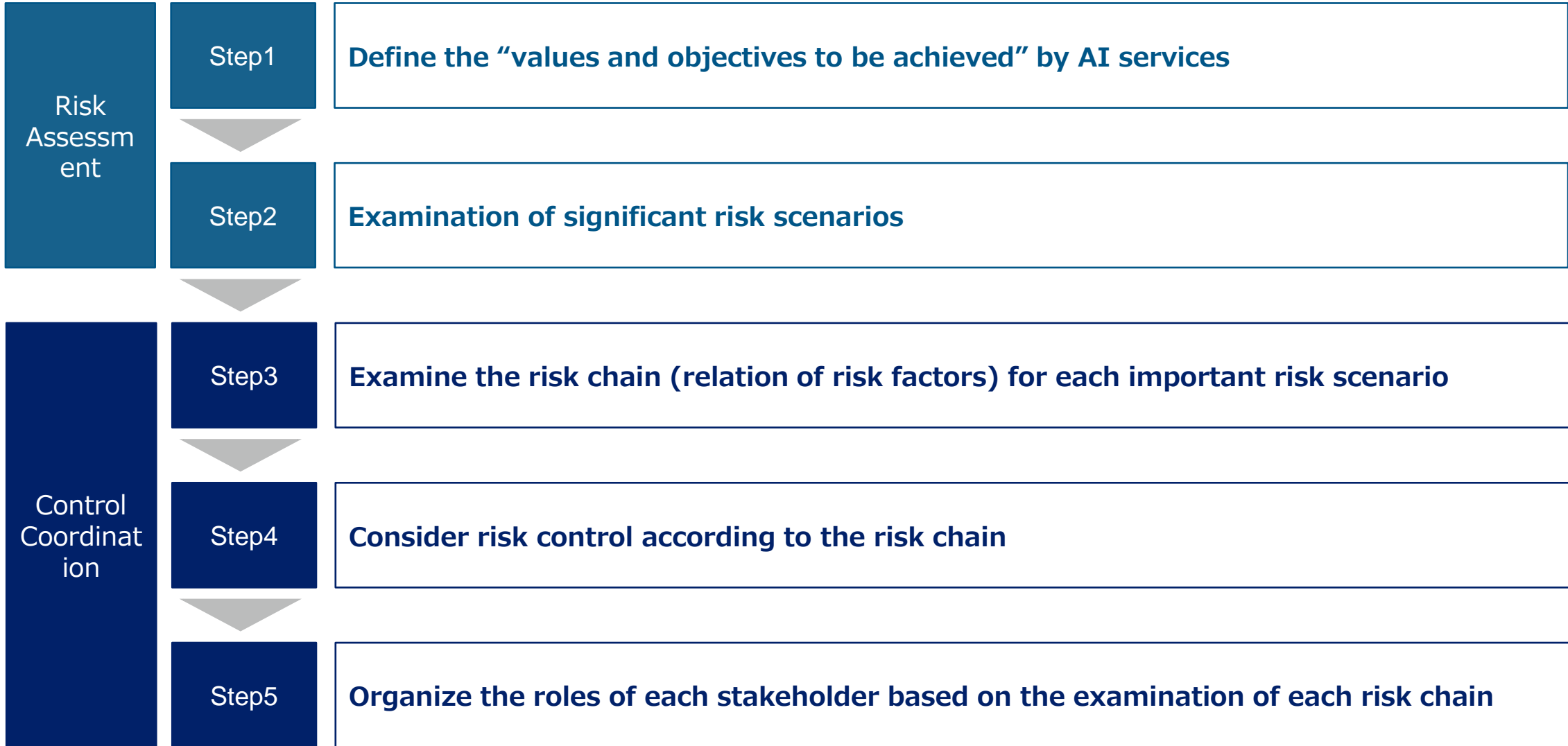


Risk Assessment & Control Coordination for AI services : Case03 Power Line Inspection AI



How to operate the RCModel

- Risk Assessment & Control Coordination -

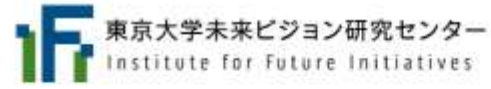




Guide book and Case Studies of Risk Chain Model

AI Service and Risk Coordination Study Group

<https://ifi.u-tokyo.ac.jp/en/projects/ai-service-and-risk-coordination/>



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How to use Risk Chain Model

[Risk Chain Model \(RCModel\) Guide Ver1.0](#)

Case Study

*These are fictional case studies below and don't raise issues or assure for any company or AI service.

[Case01.Recruitment AI \(2021/07\)](#)

Case Study



Case03 : Power Line Inspection AI

- Define the “values and objectives to be achieved” by AI services -

This is a diagnostic service that automatically detects faulty parts on a transmission line using deep-learning image analysis technology.

Visual inspection of transmission lines is conducted using a high-magnification scope by maintenance personnel. However, for transmission lines in mountainous areas where visual inspection is difficult, skilled maintenance personnel are required to inspect moving images taken by a helicopter via slow playback, which requires long work time.

Against this background, AI services have been developed for automatic inspection of transmission lines and preparation reports. The image data were taken by a drone or helicopter. Although the determination is not made in real time, the faulty parts are predicted by the AI model immediately. Inspection reports are prepared automatically following the inspection of the AI system.

[Values & Objectives]

- Ensuring inspection quality (maintaining safety)
- Reducing the burden of inspection
- Corporate social responsibility

[Flow of Actual Operations Using AI Services]

- ① Drones capture the image data of transmission lines.
- ② The AI model predicts faulty parts via image analysis of the VTR data.
- ③ The AI system prepares automatic inspection reports, including analysis results.
- ④ The maintenance team checks the report.

The deep-learning AI model was developed by Co. X, built on its cloud environment managed. Co. X receives video data from Co. P, performs inference processing, drafts reports, and sends them to Co. P. The reports include images of transmission lines in areas that appear to be abnormal. Co. P checks the content and decides whether maintenance is necessary.

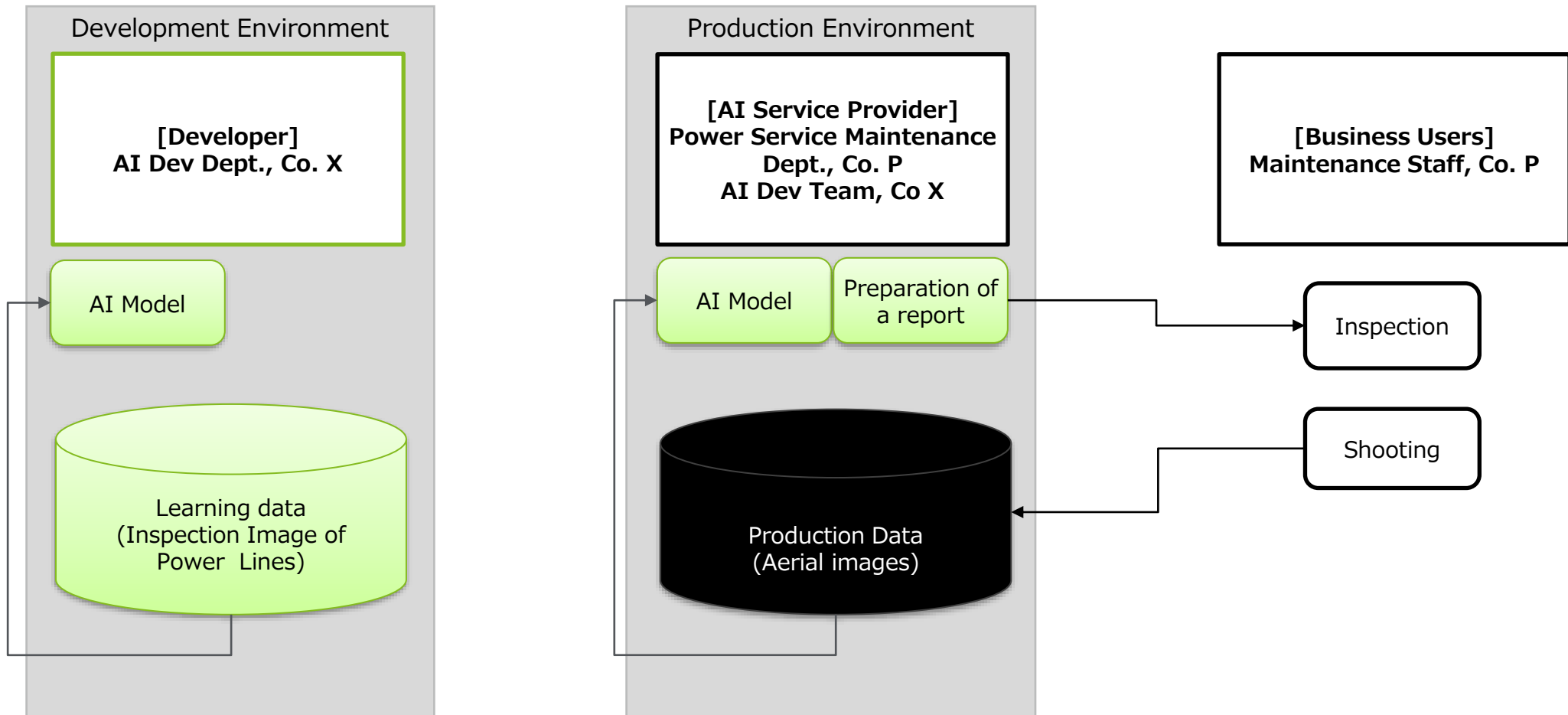
Note: although sequential learning is not performed, if the accuracy tends to deteriorate significantly after operation, Co. P will request Co. X perform additional learning or relearning as necessary.



Case03 : Power Line Inspection AI

- System Overview -

AI System	AI Dev Dept., Co. X	Detect possible abnormalities in aerial images of power lines
AI Service Provider	Power Service Maintenance Dept., Co. P	Create a report for the inspector through the detection results of the AI system.
User	Maintenance staff in Co. P	Inspect the transmission lines according to the report.



Case03 : Power Line Inspection AI

- Input & Output -

[Input Data]

Data	Purpose	Collection Method	Data Manager	Including Privacy Data
Airborne data of power transmission lines (Video)	Learning	Co. P aerial photography with helicopters and drones	Co. X (Co. X Development Environment)	Yes (*)
Airborne data of power transmission lines (Video)	Production	Co. P aerial photography with helicopters and drones	Co. P (Co. P's internal management environment and Co. X's cloud environment)	Yes (*)

[Output]

Users	Power Service Maintenance Department, Co. P
Output	Abnormal locations of transmission lines (image)
Output Method	A report is automatically generated, and images (parts considered to be abnormal) are output at the locations where abnormalities are detected in the transmission lines
Expected Accuracy	False-negative: Within 1% *Probability of recognizing an abnormality as normal *However, false-positive results are also monitored (If it's too big, people will check it too often)
User judgment	Yes
Output of evidence information	Highlights of areas of concern are included in the report
Safety Risk	Yes (Power outage possible)
Connection with external system	No
Users	Power Service Maintenance Department, Co. P



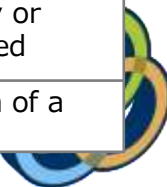
Risk Assessment



Risk Assessment

- Examination of significant risk scenarios -

Values & Objectives		Service Requirement			Risk No.	Risk Scenario	
1	Inspection quality (Maintaining safety)	1-1	Precision performance	<ul style="list-style-type: none"> Accuracy Robustness 	R001	Unstable performance	Due to deterioration in AI's predictive performance, the fault parts are overlooked, and power cannot be supplied
					R002	Impact of noise	Noise is mixed into the aerial image and the AI's judgment accuracy deteriorates
		1-2	Responding to changes in the environment	<ul style="list-style-type: none"> Robustness IoT 	R003	Changes in the external environment	Prediction performance is significantly reduced due to changes in the external environment, etc
					R004	Changes in the IoT	Appropriate judgment cannot be made due to changes in image specifications (e.g., resolution, pixels, and format) due to changes in the imaging device
		1-3	Protection from external attacks	<ul style="list-style-type: none"> Robustness Security 	R005	Malicious contamination of abnormal data	Paint on power lines to make them misunderstand, and the AI changes the decision significantly
					R006	Security protection	Inputting abnormal learning data or changing the model due to an attack from outside causes problems in the maintenance of transmission lines
2	Reduce burden for inspection	2-1	Appropriate inspection level	<ul style="list-style-type: none"> Accuracy 	R007	Over detection	Over-identification of inspection points increases inspection costs
		2-2	Easy-to-understand report	<ul style="list-style-type: none"> Explainability Easy-to-understand expression 	R008	Appropriate judgment	If the judgment basis (marked part of the image) is not output, the person in charge cannot make judgment and explain, and appropriate maintenance cannot be performed
					R009	Excessive AI dependence	Depending on the content of the report, maintenance personnel may no longer doubt the results of AI decisions
3	Corporate social responsibility	3-1	Accountability	<ul style="list-style-type: none"> Process description Verifiability 	R010	Response to quality audits	Inability to provide appropriate explanations when subjected to quality audits
					R011	Investigation at the time of trouble	When an external explanation is required due to the occurrence of abnormality or trouble, the cause and preventive measures cannot be considered and explained
		3-2	Data Protection	<ul style="list-style-type: none"> Data protection 	R012	Harmful rumors	Leakage of AI prediction (abnormality detection point) damages the reputation of a specific areas



Risk Assessment & Control Summary

- Organize the roles of each stakeholder based on the examination of each risk chain -

Values & Objectives	Risk No.	Risk Scenario	Uncertainty	Environmental change	Caused by user	RC	Control Summary		
							AI System	AI service provider	User
1 Inspection quality (Maintaining safety)	R001	Unstable performance	○			●	Ensuring a sufficient accuracy rate Recording the results of AI decisions	Confirmation of power supply status Periodic image verification relearning	Switching rule for alternative operation Alternative investment system
	R002	Impact of noise	○	○		●	Camera specification definition Image noise correction Robustness of the model	Maintaining the shooting distance Image verification at the same point Relearning	
	R003	Changes in the external environment	○	○		●	Development of multiple models Parallel execution of multiple models	Multiple model development system Performance monitoring	
	R004	Changes in the IoT	○	○		●	*Same as R002	*Same as R002	*Same as R002
	R005	Malicious contamination of abnormal data	○	○		●	*Same as R002	*Same as R002	*Same as R002
	R006	Security protection					Security management	Investigation and improvement of causes	
2 Reduce burden for inspection	R007	Over detection	○			●	Ensuring a sufficient accuracy rate Overdetection warning	Defining Inspection Levels Reference information for the report Investigating the cause of overdetection	Rules for selecting inspection points Demand for model improvement
	R008	Appropriate judgment	○		○	●	*Include in the R009	*Include in the R009	*Include in the R009
	R009	Excessive AI dependence	○		○	●	Output of the rationale	The basis for judgment and reference information are included in the report.	Ensuring knowledge of inspection services Consideration of misjudgment
3 Corporate social responsibility	R010	Response to quality audits	○			●	Record data comprehension Record the performance of the model Recording the results of AI decisions	Internal audit Response to external audits Access control	
	R011	Investigation at the time of trouble	○				Save log data	System operation monitoring Fault handling	Manual alternative operation
	R012	Harmful rumors					Data protection	Education on professional ethics	Education on professional ethics

Organization

- Organize the roles of each stakeholder based on the examination of each risk chain -

Step5

Co. P) Top Management

- Values and Objectives
- Approval risk controls

Co. P) Legal Dept.

Co. P) Internal Audit Dept.

- Internal audit
- Response to external audits

- AI Service Provider - Co. P) Power Service Maintenance Dept.

- Confirmation of power supply
- Defining inspection levels
- Maintaining the shooting distance
- Periodic image verification
- Image verification at the same point
- The basis for decision and reference information are included in the report.
- Multiple model development system
- Performance monitoring
- Relearning
- Response to internal audits

Co. X) AI Dev Dept.

- Securing the accuracy rate of AI models
- Camera specification definition
- Image noise correction
- Robustness of the model
- Decision basis output of the model
- Alert upon over-detection
- Development of multiple models
- Parallel execution of multiple models

Co. X) Cloud Service Dept.

- Recording the results of AI decisions
- Save log data

Co. P) Power Line Management Dept.

- Information coordination of power supply status

Ministry of Land, Infrastructure, Transport and Tourism

Electric power company

- User - Co. P) Maintenance Staff

- Knowledge and skill for inspection
- Consideration of misjudgment
- Inspection rules for over-detection
- Switching rule and system for alternative operation
- Demand for model improvement



Control Coordination



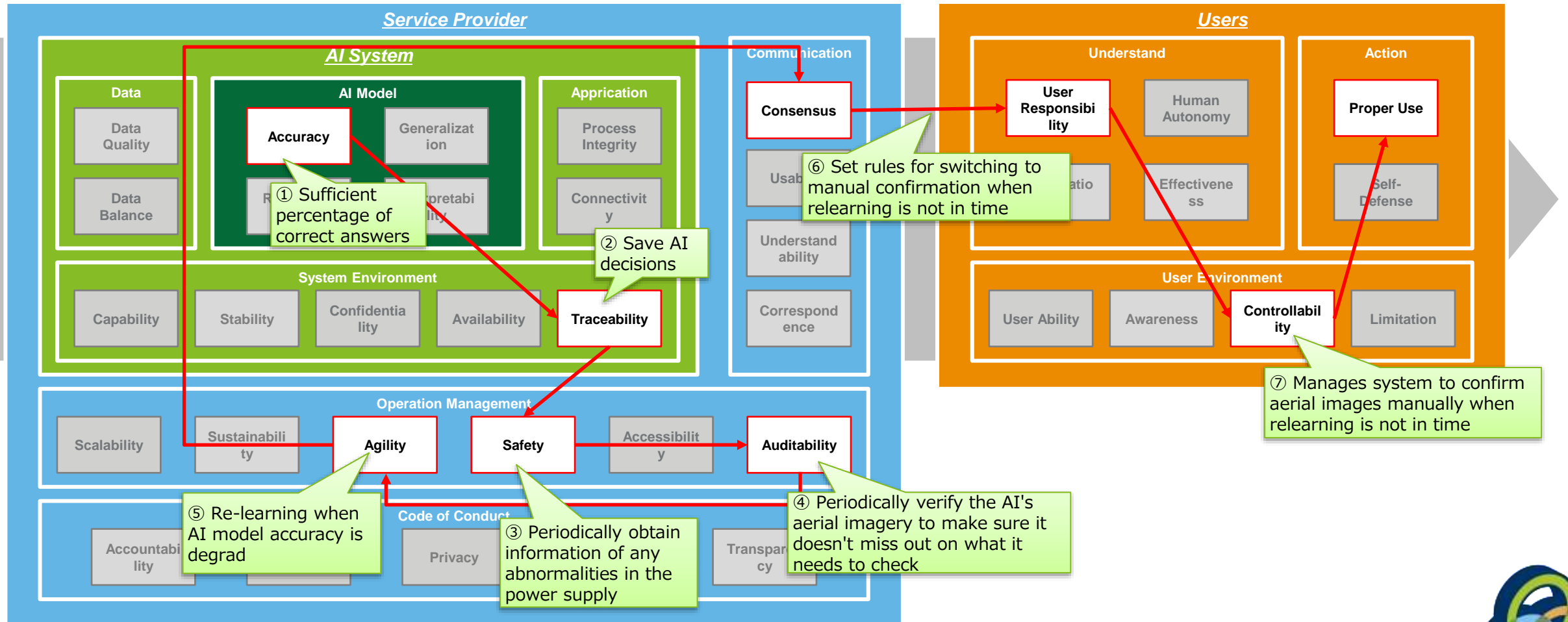
Control Coordination

- Examine the risk chain (relation of risk factors) for each important risk scenario -

R001

Maintenance of predictive performance

Due to deterioration in AI's predictive performance, the fault parts are overlooked, and power cannot be supplied



Risk Control

- Consider risk control according to the risk chain -

R001

Maintenance of predictive performance

Due to deterioration in AI's predictive performance, the fault parts are overlooked, and power cannot be supplied

Risk Control		
AI System (AI dev dept., Co. A)	AI Service Provider (HR dept., Co. A)	User (Person in HR dept., group A)
<p>① [Accuracy] Ensuring a sufficient accuracy rate of models when learning (AI Dev Dept., Co. X)</p> <p>② [Traceability] Stores information on AI judgment results when using (Cloud Service Dept., Co. X)</p>	<p>③ [Safety] Obtain regular information from the power transmission management division on whether there is any abnormality in the power supply (Power Line Management Dept., Co. P / Power Service Maintenance Dept., Co. P)</p> <p>④ [Auditability] Periodically and comprehensively verify aerial images to make sure that AI does not overlook areas to be inspected (Power Service Maintenance Dept., Co. P)</p> <p>⑤ [Agility] Asks for relearning of AI models to ensure sufficient accuracy (Power Service Maintenance Dept., Co. P /AI Dev Team, Co. X)</p> <p>⑥ [Consensus] In case that relearning cannot be done in time, an alternative operation by human should be decided (Power Service Maintenance Dept., Co. P).</p>	<p>⑥ [User Responsibility] In case that relearning cannot be done in time, make arrangements for manual alternative operation (Maintenance Staff in Co. P)</p> <p>⑦ [Controllability] Control system to confirm aerial images manually when relearning is not in time (Power Service Maintenance Dept., Co. P / Maintenance Staff in Co. P)</p> <p>⑧ [Proper Use] When relearning cannot be done in time, substitute operation by human (Maintenance Staff in Co. P)</p>



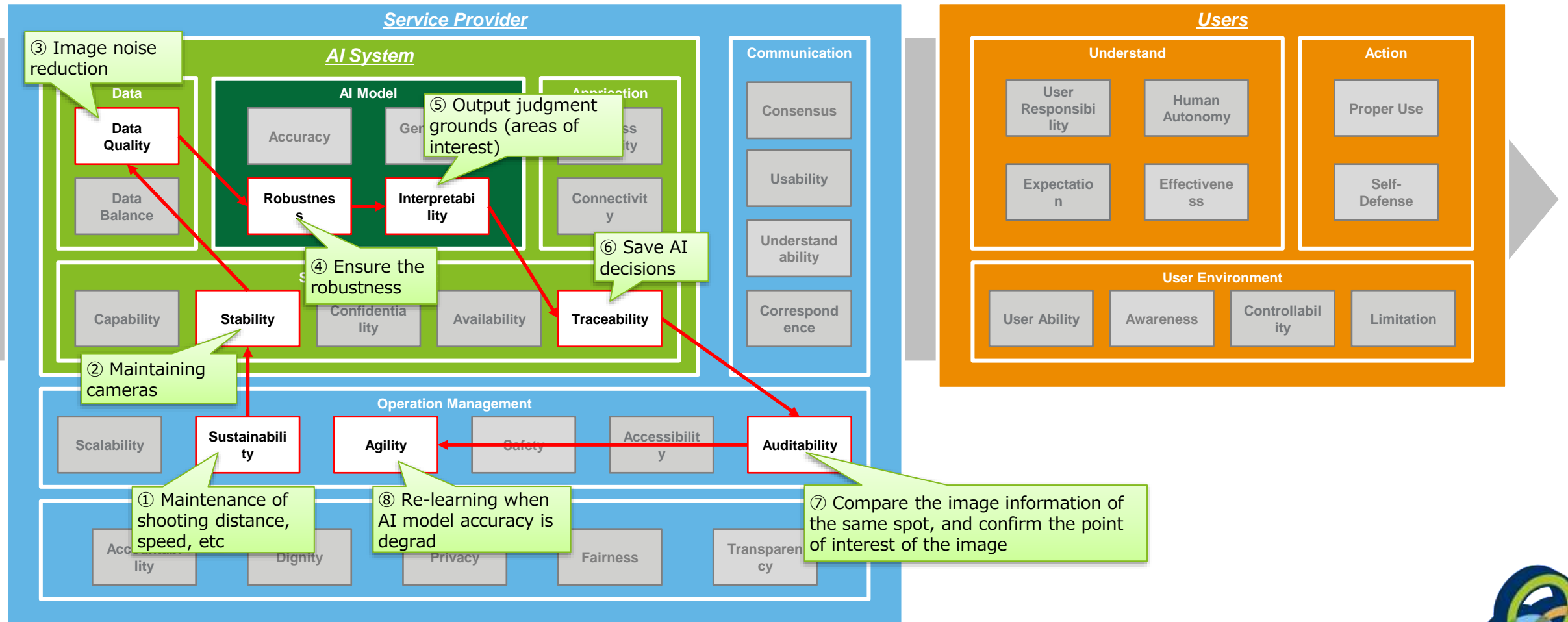
Control Coordination

- Examine the risk chain (relation of risk factors) for each important risk scenario -

R002

Impact of noise

Noise is mixed into the aerial image and the AI's judgment accuracy deteriorates



Risk Control

- Consider risk control according to the risk chain -

R002

Impact of noise

Noise is mixed into the aerial image and the AI's judgment accuracy deteriorates

Risk Control		
AI System (AI dev dept., Co. A)	AI Service Provider (HR dept., Co. A)	User (Person in HR dept., group A)
<p>② [Stability] Clarify the required specifications of the camera and perform regular maintenance (AI Dev Dept., Co. X /Power Service Maintenance Dept., of Co. P)</p> <p>③ [Data Quality] Degradation of image data by noise correction, etc (AI Dev Dept., Co. X)</p> <p>④ [Robustness] Learning to enhance model robustness (AI Dev Dept., Co. X)</p> <p>⑤ [Interpretability] Outputs the judgment basis of the model (points of interest in the image) (AI Dev Dept., Co. X)</p> <p>⑥ [Traceability] Stores information on AI judgment results when using (Cloud Service Dept., Co. X)</p>	<p>① [Sustainability] Maintains the shooting distance and speed of helicopters and drones so that the image information does not change significantly depending on the shooting date (Power Service Maintenance Dept., Co. P)</p> <p>⑦ [Auditability] Compare the image information of the judgment result of the same point, and confirm whether the focus of the image has clearly changed (Power Service Maintenance Dept., Co. P)</p> <p>⑧ [Agility] Asks for relearning of AI models to ensure sufficient accuracy (Power Service Maintenance Dept., Co. P / AI Dev Team, Co. X)</p>	



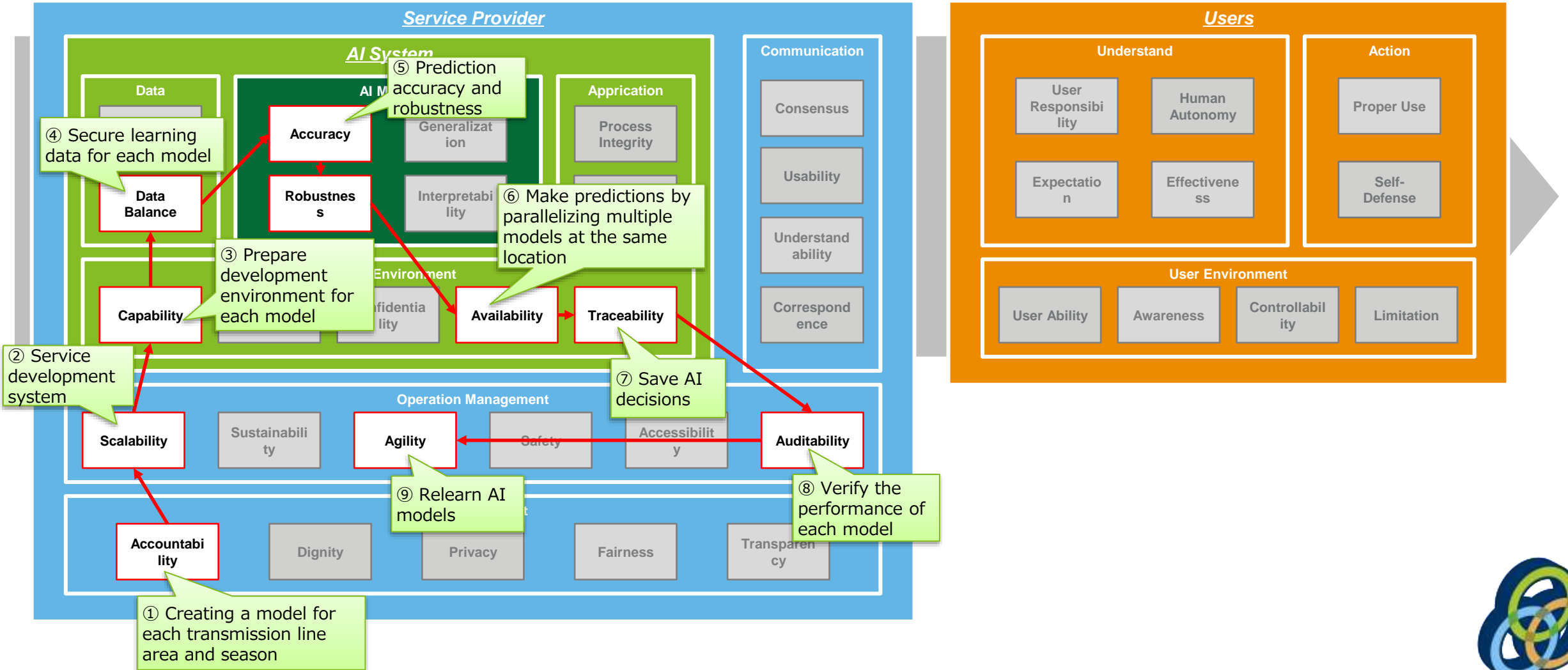
Control Coordination

- Examine the risk chain (relation of risk factors) for each important risk scenario -

R003

Changes in the external environment

Prediction performance is significantly reduced due to changes in the external environment, etc



Risk Control

- Consider risk control according to the risk chain -

R003

Changes in the external environment

Prediction performance is significantly reduced due to changes in the external environment, etc

Risk Control		
AI System (AI dev dept., Co. A)	AI Service Provider (HR dept., Co. A)	User (Person in HR dept., group A)
<p>③ [Capability] Prepare a development environment for each model (AI Dev Dept., Co. X)</p> <p>④ [Data Balance] Prepare sufficient learning data for each model (AI Dev Dept., Co. X)</p> <p>⑤ [Accuracy/Robustness] Learning to ensure predictive accuracy and robustness of models (AI Dev dept., Co. X)</p> <p>⑥ [Availability] Parallelizing and predicting multiple models at the same location (For example, a model developed for each season and weather is used to predict abnormal locations at the same location) (AI Dev Dept., Co. X)</p> <p>⑦ [Traceability] Stores information on AI judgment results when using (Cloud Service Dept., Co. X)</p>	<p>① [Accountability] Consider whether to create a model for each transmission line area and season (Power Service Maintenance Dept., Co. P)</p> <p>② [Scalability] Ensuring sufficient development structure for service provision according to the number of models, etc (Power Service Maintenance Dept., Co. P / AI Dev Team, Co. X)</p> <p>⑧ [Auditability] Periodically verify the performance of each model (Power Service Maintenance Dept., Co. P)</p> <p>⑨ [Agility] Asks for relearning of AI models to ensure sufficient accuracy (Power Service Maintenance Dept., Co. P / AI Dev Team, Co. X)</p>	



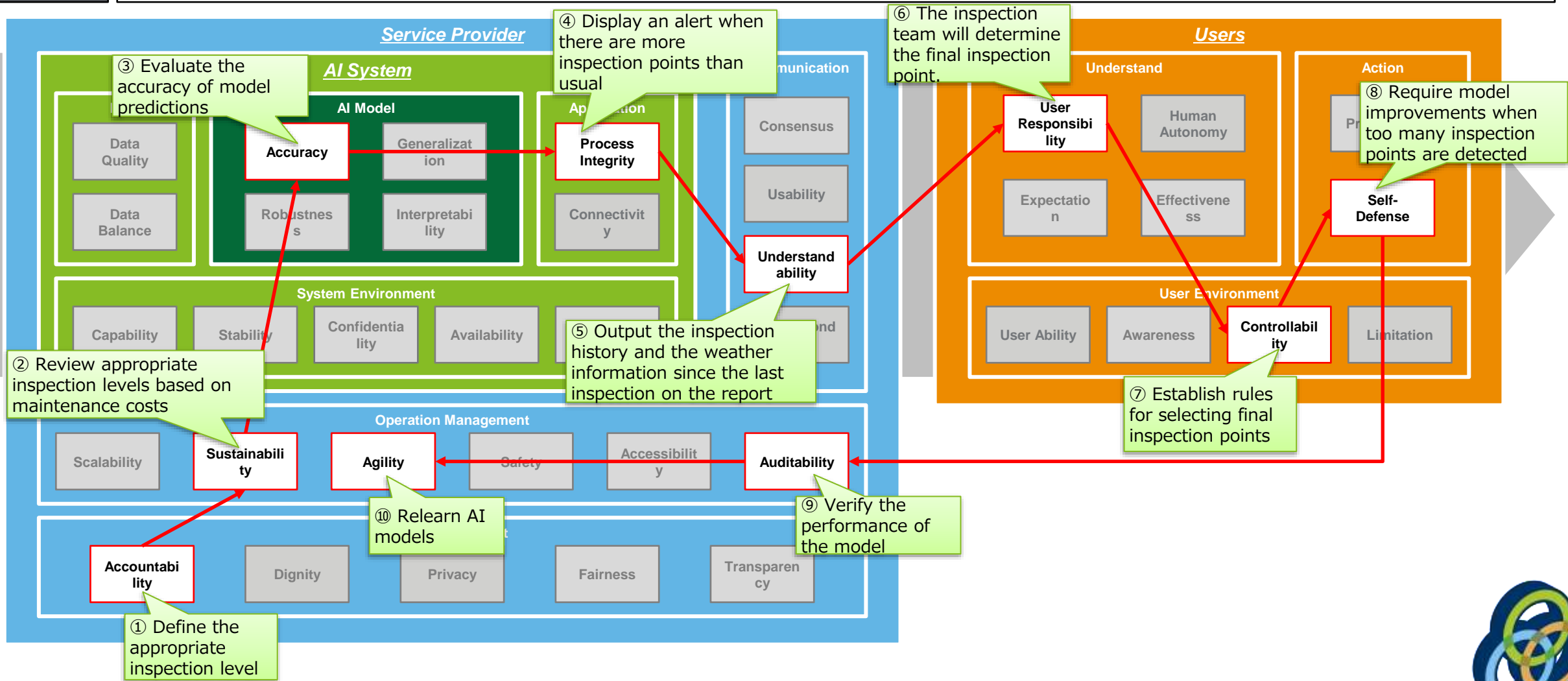
Control Coordination

- Examine the risk chain (relation of risk factors) for each important risk scenario -

R007

Over detection

Over-identification of inspection points increases inspection costs



Risk Control

- Consider risk control according to the risk chain -

R007

Over detection

Over-identification of inspection points increases inspection costs

Risk Control		
AI System (AI dev dept., Co. A)	AI Service Provider (HR dept., Co. A)	User (Person in HR dept., group A)
<p>③ [Accuracy] Learning to ensure model prediction accuracy (AI Dev Dept., Co. X)</p> <p>④ [Process Integrity] Display an alert when an excessive number of inspection points are detected (AI Dev Dept., Co. X)</p>	<p>① [Accountability] Define an appropriate inspection level (Power Service Maintenance Dept., Co. P)</p> <p>② [Sustainability] Review appropriate inspection levels (model performance) based on maintenance costs (Power Service Maintenance Dept., Co. P)</p> <p>⑤ [Understandability] Information such as the inspection history of inspection points and the weather since the last inspection is output on the report (Power Service Maintenance Dept., Co. P)</p> <p>⑨ [Auditability] Verify the performance of each model and confirm the reason for over-detection (Power Service Maintenance Dept., Co. P)</p> <p>⑩ [Agility] Asks for relearning of AI models to ensure sufficient accuracy (Power Service Maintenance Dept., Co. P / AI Dev Team, Co. X)</p>	<p>⑥ [User Responsibility] Understand that the final inspection point is determined by the inspection team (Power Service Maintenance Dept., Co. P)</p> <p>⑦ [Controllability] Rules for selecting final inspection points (Maintenance Staff in Co. P)</p> <p>⑧ [Self-Defense] Require model improvements if too many inspection points are detected (Maintenance Staff in Co. P)</p>



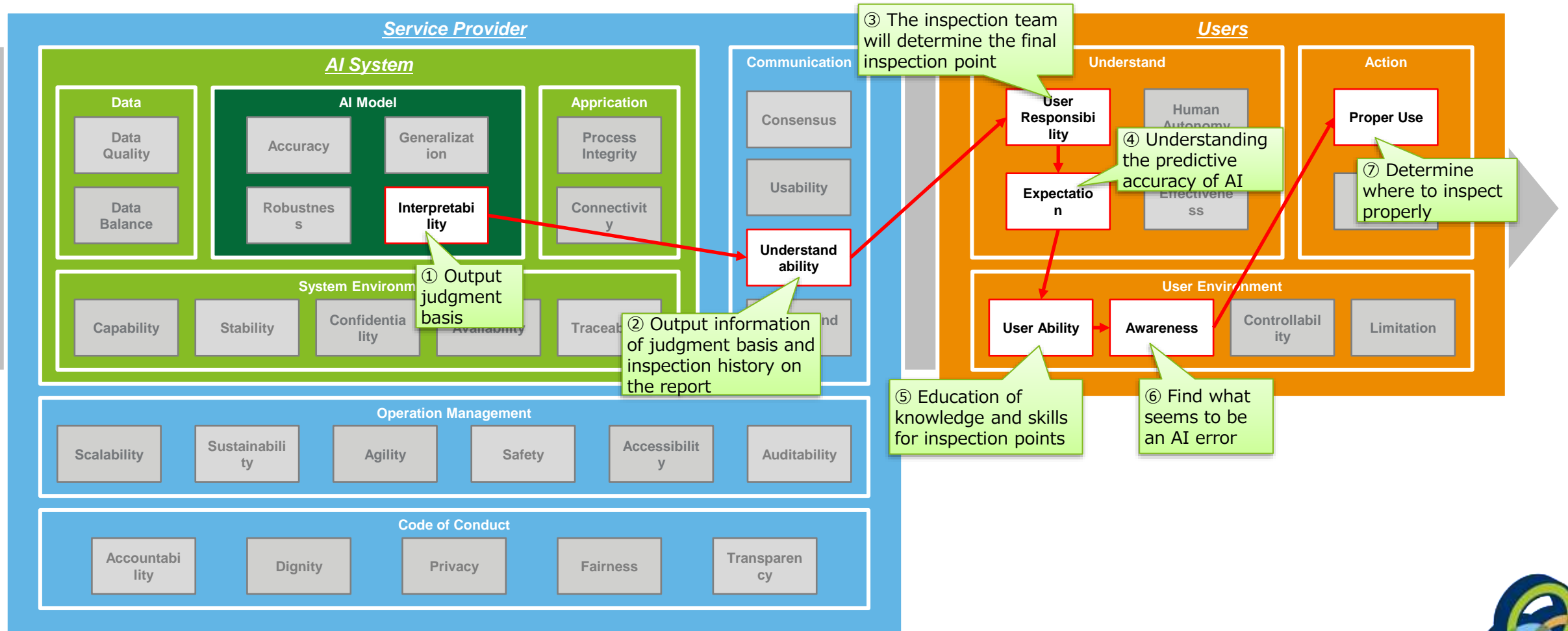
Control Coordination

- Examine the risk chain (relation of risk factors) for each important risk scenario -

R009

Excessive AI dependence

Depending on the content of the report, maintenance personnel may no longer doubt the results of AI decisions



Risk Control

- Consider risk control according to the risk chain -

R009

Excessive AI dependence

Depending on the content of the report, maintenance personnel may no longer doubt the results of AI decisions

Risk Control		
AI System (AI dev dept., Co. A)	AI Service Provider (HR dept., Co. A)	User (Person in HR dept., group A)
① [Interpretability] Outputs the judgment basis of the model (AI Dev Dept., Co. X)	② [Understandability] Outputs reference information such as judgment grounds of inspection points and inspection history on the report (Power Service Maintenance Dept., Co. P)	③ [User Responsibility] Understand that the final inspection point is determined by the inspection team (Power Service Maintenance Dept., Co. P) ④ [Expectation] Understanding the accuracy of model judgments (Power Service Maintenance Dept., Co. P) ⑤ [User Ability] Education of knowledge and skills necessary to determine inspection points (Power Service Maintenance Dept., Co. P / Maintenance Staff in Co. P) ⑥ [Awareness] Finding places where AI seems to have made mistakes (Maintenance Staff in Co. P) ⑦ [Proper Use] Determine appropriate inspection points (Maintenance Staff in Co. P)



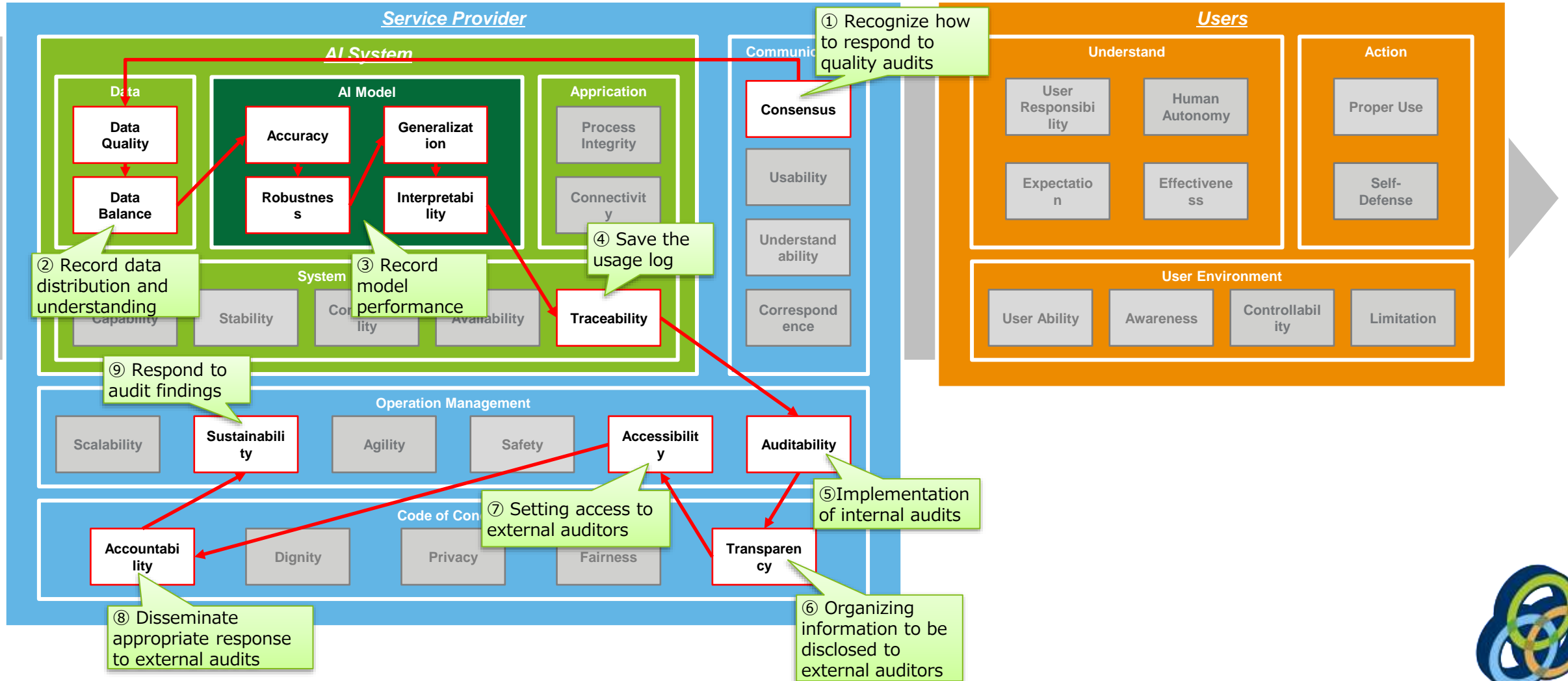
Control Coordination

- Examine the risk chain (relation of risk factors) for each important risk scenario -

R010

Response to quality audits

Inability to provide appropriate explanations when subjected to quality audits



Risk Control

- Consider risk control according to the risk chain -

R010

Response to quality audits

Inability to provide appropriate explanations when subjected to quality audits

Risk Control		
AI System (AI dev dept., Co. A)	AI Service Provider (HR dept., Co. A)	User (Person in HR dept., group A)
<p>② [Data Quality/Data Balance] Record data distribution and understanding (AI Dev Dept., Co. X)</p> <p>③ [Accuracy/Robustness/Generalization] [Interpretability] Record Model Performance (AI Dev Dept., Co. X)</p> <p>④ [Traceability] Record the results of AI decisions (Cloud Service Dept., Co. X)</p>	<p>① [Consensus] Organize the division of roles and information to be disclosed when responding to audits (Power Service Maintenance Dept., Co. P)</p> <p>⑤ [Auditability] Conduct internal audits and respond in advance (Internal Audit Dept., Co. P)</p> <p>⑥ [Transparency] Organize information to be disclosed to external auditors (Power Service Maintenance Dept., Co. P)</p> <p>⑦ [Accessibility] Set necessary access rights for external auditors (Power Service Maintenance dept., Co. P)</p> <p>⑧ [Accountability] Disseminate appropriate response to external audits (Power Service Maintenance Dept., Co. P)</p> <p>⑨ [Sustainability] Responding to issues discovered during the audit (Power Service Maintenance Dept., Co. P)</p>	

