Design of maintenance and quality stabilization services considering diversity of machine tools

Robot Revolution Initiative
WG for manufacturing business revolution through IoT
The Industrial Machinery Steering committee

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Overview

Objective

Design of maintenance and quality management services expanding two use cases implemented in 2018, where decision makings require integration of the data of machine tools in a (even distributed) production line regardless of tools types and manufacturers to evaluate their feasibility from business and usage viewpoints.

- Case 1: Automating maintenance and recovery activities
- Case 2: Quality stabilization in continuous production

Approach

Through discussions of experts in machine tool industry, a business model as well as usage scenarios of the two cases are designed identifying the information that can be used for the cases regardless of who own it.
Business and usage viewpoint models of IIRA [1] are employed.

[1] Industrial Internet Consortium, 2017, The Industrial Internet of Things Volume G1: Reference Architecture Ver.1.8, https://www.iiconsortium.org/IIC_PUB_G1_V1.80_2017-01-31.pdf

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Case 1: Automation of maintenance and recovery activities: Business View

Background

- An Example of Application Scenario Value-Based Services

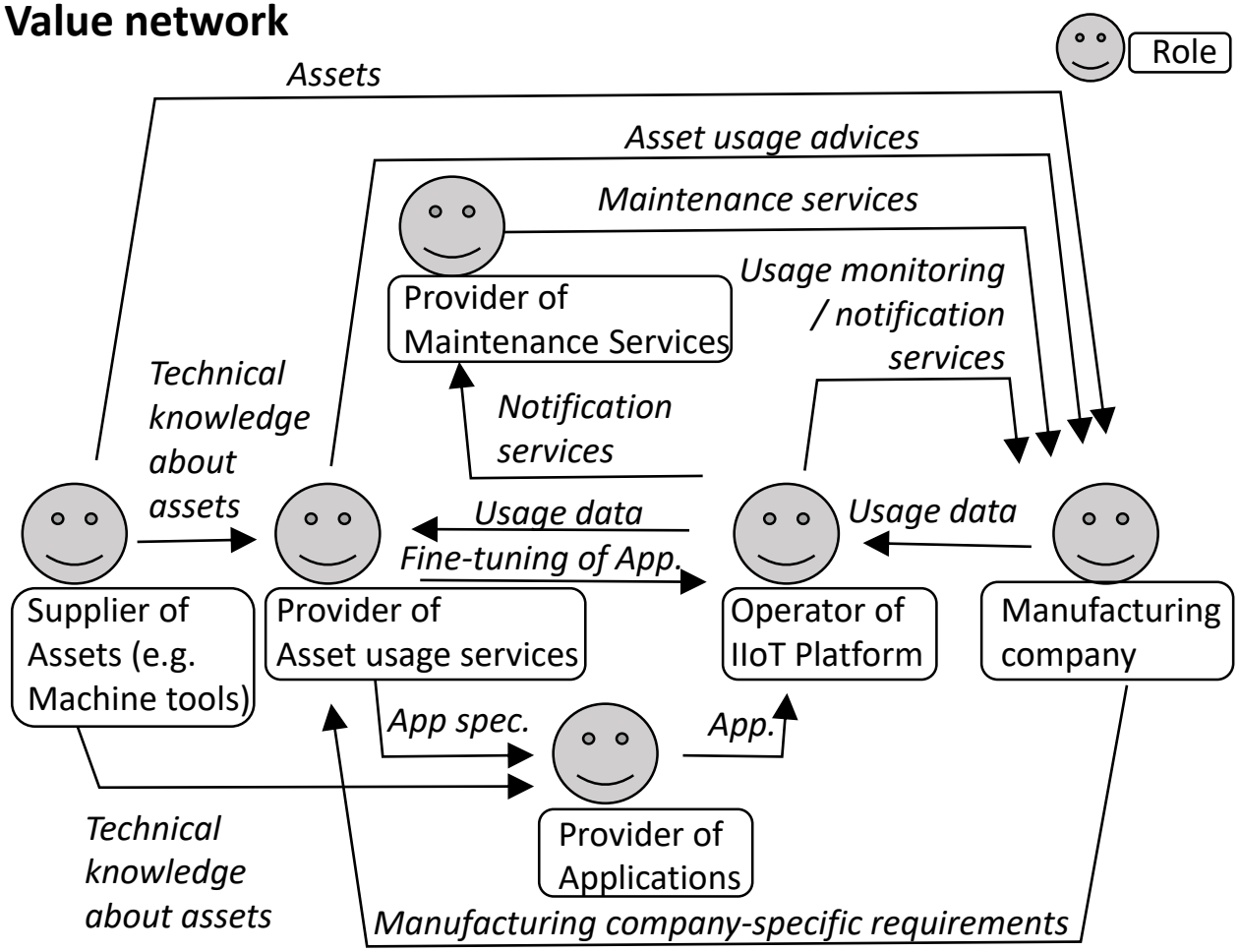
Value proposition

- Usage data collected and analyzed by applications on IIoT platform specifies conditions on executing (partially automated) services.
- The applications are fine-tuned with technical knowledge about assets and manufacturing company-specific requirements.
- The services can be integrated with production planning and execution.

Revenue mechanism

- Manufacturing company pays for asset usage monitoring services supporting operational decision makings on asset utilization.
- Manufacturing company pays for asset usage advices supporting tactical decision makings (evaluation of asset usage policy).
- Manufacturing company or provider of maintenance services in contract pays subscription services for optimal maintenance and recovery of assets.

Value network



- Single stakeholder can assume multiple roles and multiple stakeholders can perform the same role.
- Assignment of the roles to stakeholders is business specific.

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Case 1: Automation of maintenance and recovery activities : Usage View

Major Activities

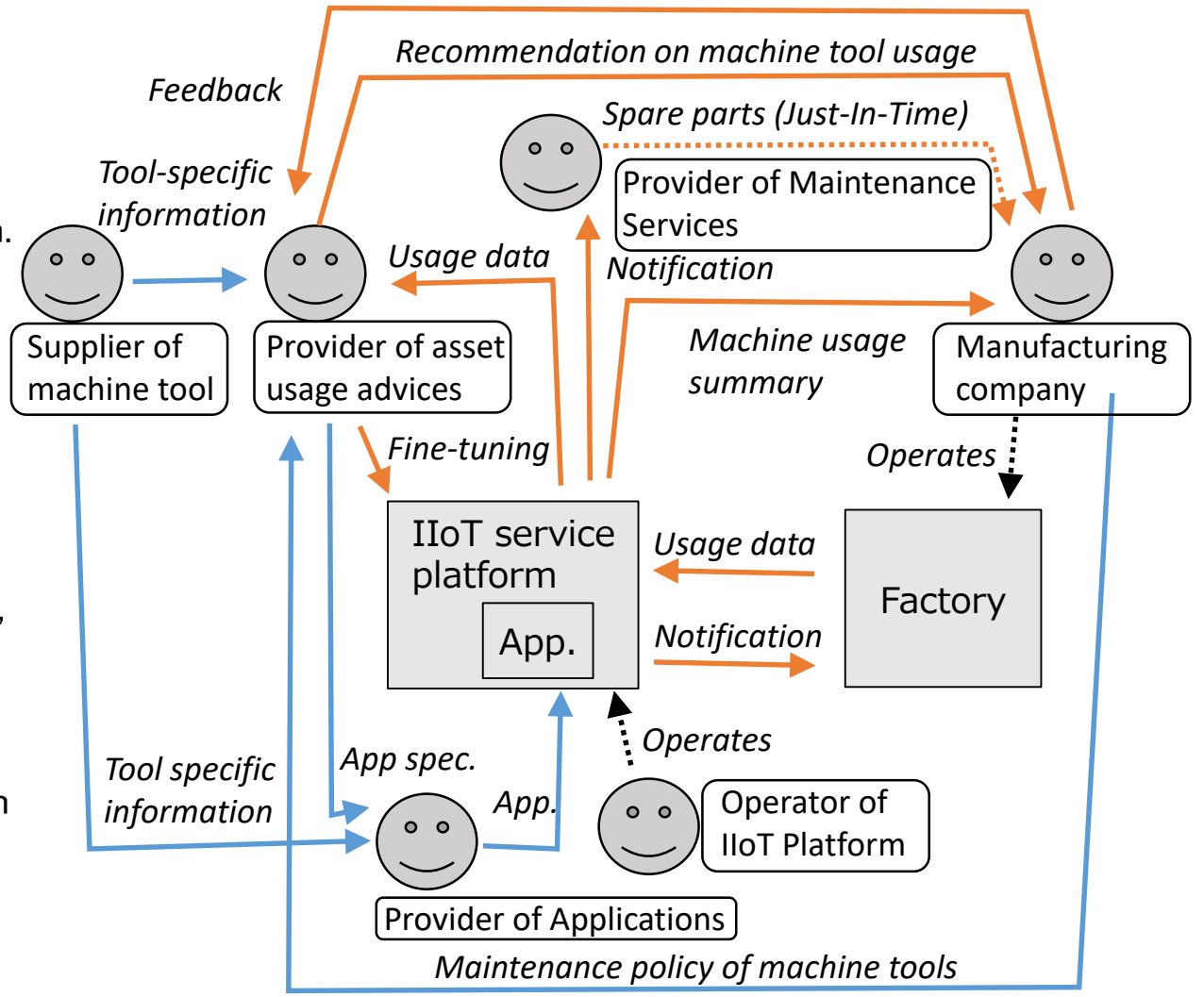
Set-up stage

- Manufacturing company (MC) defines maintenance policy for machine tools.
- Provider of asset usage advices formulates the specifications on the monitoring and notification application.
- Provider of applications implements the application and installs on the IoT service platform.
- Supplier of machine tools offers machine tool-specific information useful for development and fine-tuning of the application.

Operation and maintenance stage

- MC (automatically) updates the state of machine tools (e.g., process parameters) when notified by the application.
- MC monitors machine tool usage with the application and performs maintenance (e.g., repair or replacement of parts).
- Provider of maintenance services delivers spare parts when notified by the application (just-in-time).
- Provider of asset usage advices gives recommendations about machine tool usage to MC and fine-tunes the application following the feedback from MC.

Information Flows on System under Consideration



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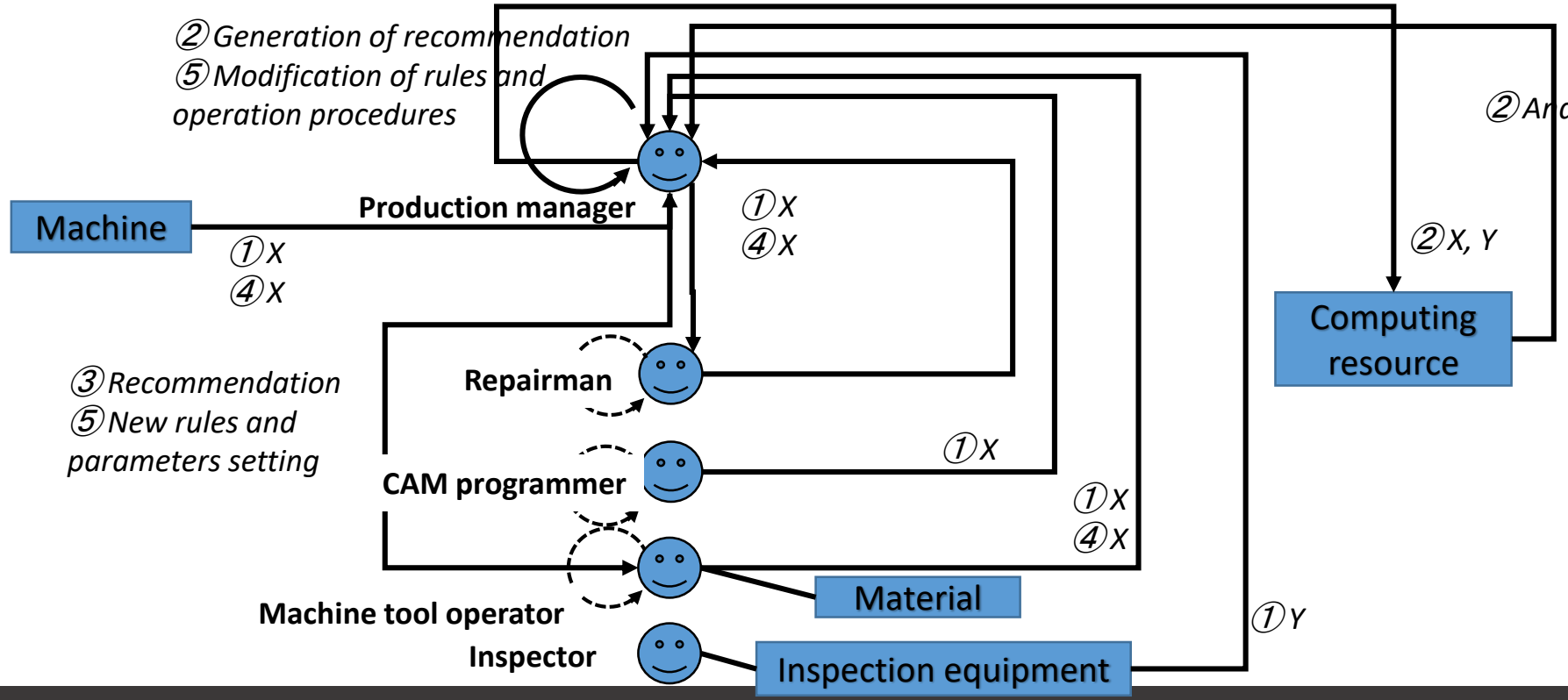
Case 2: Quality stabilization

- Target: quality control and management in continuous production
  - The quality of finished workpiece inevitably vary even though they are processed by the same machines with the same setups.
  - Support a production manager to stabilize quality of finished workpiece
    - Collect every usual/unusual actions (and parameter values) executed by asset operators and repairmen as well as time series conditions of assets and environment.
    - Analyze correlation between quality and collected information
    - Generate recommendation action based on the analysis result



X: Information obtained from machine tools, operator and repairman of machine tools, and CAM programmer (conditions, parameter values, details of executed actions, etc.)

Y : Quality information obtained from inspection equipment, customer of finished products, etc.

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Case 2: Quality stabilization (Business view)

Background

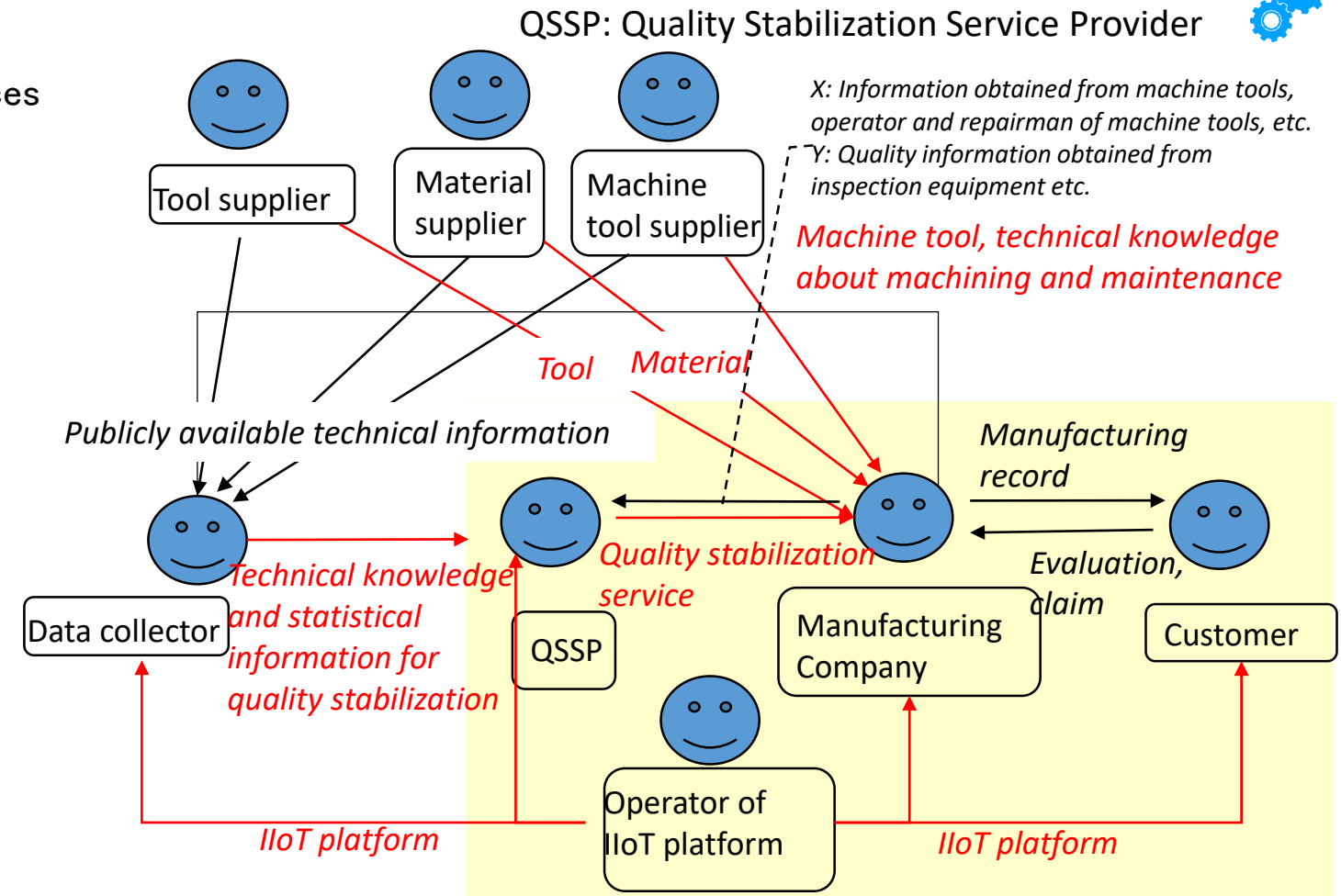
- An Example of Application Scenario Value-Based Services

Value proposition

- Publicly available information collected, analyzed and interpreted by data collector is used for Quality Stabilization Service Provider (QSSP)
- Operation and maintenance data collected and correlated with quality inspection results (incl. claim) on IIoT platform generates operation and maintenance recommendation for manufacturing company, by using technical knowledge and statistical information provided by data collector.

Revenue mechanism

- Manufacturing company pays for quality stabilization services supporting operational decision makings on quality control and management.
- QSSP pays for technical knowledge and statistical information provided by data collector.



Data collector, who collects public information from a number of parties and provides summary and analysis results via service platform, plays a central role.
IIoT platform used by a quality stabilization service provider can be different from that used by data collectors and other parties.

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Case 2: Quality stabilization (usage view)

Major activities for supporting SDCA

Do/Act

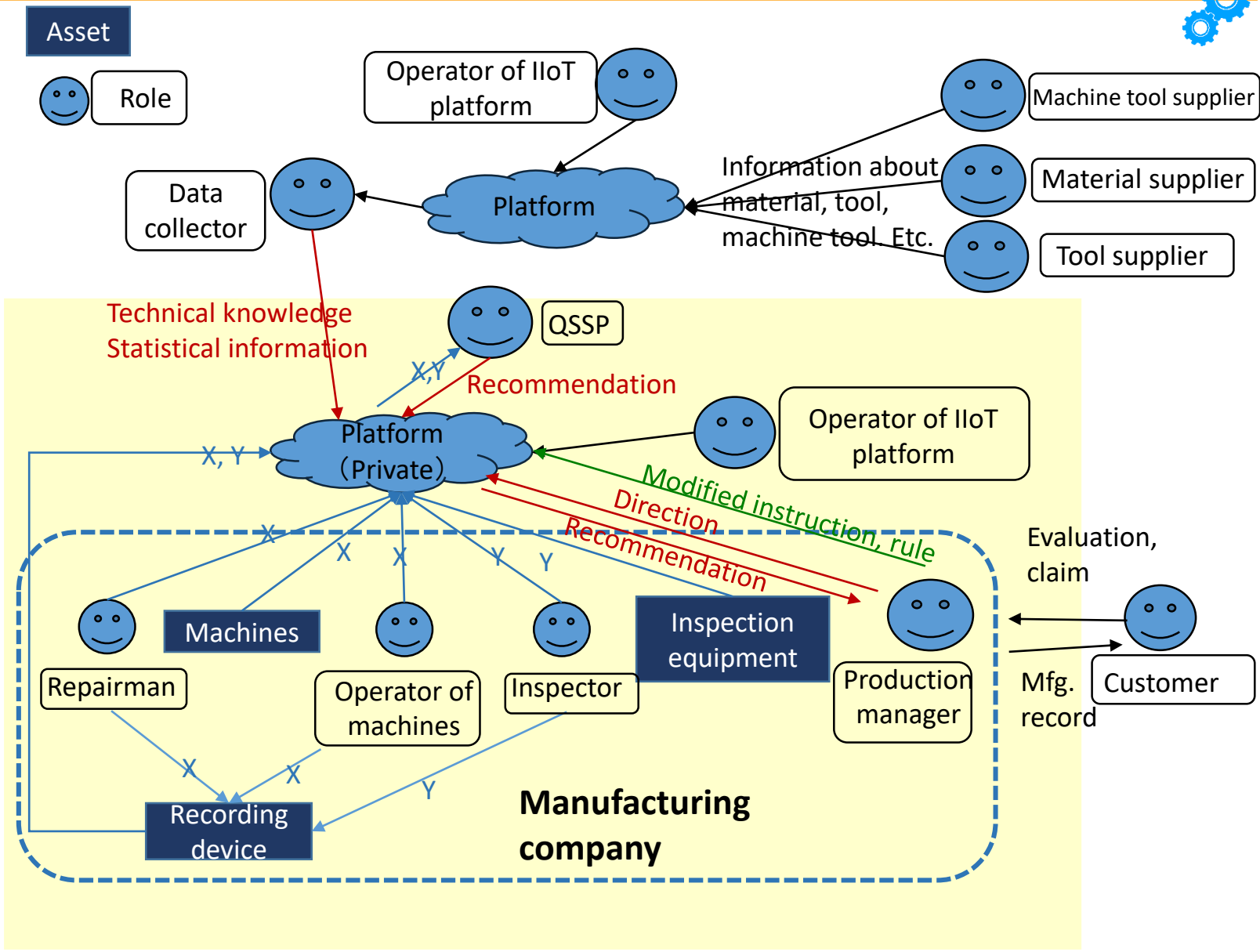
- Operator of machines and repairmen execute their operation based on pre-defined instruction (or direction from production manager)
- Machines, inspection equipment, and recording device record every actions of operators and repairmen as well as state, conditions and parameter values of machines (X).

Check

- Production manager analyzes time series variation in quality (Y) to find out sign of degradation.
- Quality Stabilization Service Provider (QSSP) analyze relationship between X and Y and generate operation recommendation.
- Production manager determines quality recovering actions and sends directions.

Standardize (Generalize)

- Production manager evaluates the efficiency and effectiveness of the actions and determine/modify operation instruction. He/she also modifies data items to be recorded.



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