

Collaboration between Service and R&D Organizations – Two Cases in Automation Industry

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Abstract

Industrial automation systems are long-lasting multi-technological systems that need industrial services in order to keep the system up-to-date and running smoothly. The Service organization needs to jointly work internally with R&D and externally with customers and COTS providers so as to operate efficiently. This paper focuses to Service – R&D collaboration. It presents a descriptive case study of how the working relationship between Service and R&D organizations has been established in a two example industrial service cases (upgrade and audit cases). The article reports the collaboration practices and tools that have been defined for these industrial services. This research provides, for other companies and research institutes that work with industrial companies, practical real-life cases of how Service and R&D organizations collaborate together. Other companies would benefit from studying the contents of the cases presented in this article and applying these practices in their particular context, where applicable.

Keywords: *Automation systems, Industrial service, Lifecycle, Transparency, Collaboration.*

1. Introduction

Industrial automation systems are used in various industrial segments, such as power generation, water management and pulp and paper. The systems comprise HW and SW sub-systems that are developed in-house or COTS (Commercial Off-The-Shelf) components. Since these systems have a long useful life, the automation system providers offer various different kinds of lifecycle services for their customers in order to keep their automation systems running smoothly.

Integrated service/product development has been studied quite a bit, e.g. in [1, 2]. However, there is less information available how in practice the needs of the Service organization could be taken into account during product development. What kind of Service/R&D collaboration could improve the quality and lead time of the industrial

services? In this article, the objective is not to describe the service development process, but rather to try to understand and collect industrial best practices that increase the collaboration and transparency between the Service and R&D organizations so that customers can be serviced better and more promptly.

This article intends to discuss the collaboration between the Service and R&D organizations using two cases that provide practical examples about the collaboration, i.e. *what the collaboration and transparency between the Service and R&D organizations mean in a real-life industrial environment.* In addition, the paper reports what kind of solutions the company in the case study uses to effectuate the collaboration.

The paper is organized as follows. In the next section, background and need for Service and R&D collaboration are stated. In section 3, the case context and research process is introduced. In section 4, two industrial service processes are introduced that are cases for analyzing Service and R&D collaboration. In section 5, the cases are analyzed from Service and R&D collaboration viewpoint. Finally, section 6, discusses the results and draws up the conclusions.

2. Background

In the digital economy, products and services are linked more closely to each other. The slow economic growth during recent years has boosted the development of product-related services even more – they have brought increasing revenue for the manufacturing companies in place of traditional product sales [3, 4]. The global market for product and service consumption is constantly growing [5]. In 2012, the overall estimate for service revenues accrued from automation products like DCS, PLC,

SCADA, etc. amounted to nearly \$15 billion [6]. Customers are more and more interested in value-added services compared to the basic products itself. Therefore, companies and business ecosystems need the ability to adapt to the needs of the changing business environment. The shift from products to services has been taking place in the software product industry from 1990 onwards [7]. The importance of service business has been understood for a while, but more systematic and integrated product and service development processes are needed [8]. During recent years the focus has shifted towards understanding the customer's needs and early validation of the success of developed services [9]. Furthermore, the separation of service and R&D organization may cause communication problems that need to be tackled with new practices and organizational units [10].

Technical deterioration (technology, COTS, standards, etc.) of the systems that have a long lifetime (such as automation systems) is a problem in industry. The reliability of technical systems will decrease over time if companies ignore industrial services. "For a typical automation/IT system, only 20-40 percent of the investment is actually spent on purchasing the system; the other 60-80 percent goes towards maintaining high availability and adjusting the system to changing needs during its life span" [11]. This is huge opportunity for vendors to increase their industrial service business. Automation system providers offer their automation systems and related industrial services in order to keep customer's industrial processes running smoothly. These industrial services need to be done efficiently. Therefore, there should be systematic and effective service processes with supporting IT systems in global operational environment. Furthermore, there should be collaboration practices with R&D and Service organization that systems can be efficiently serviced and are service friendly. This all requires deeper understanding how Service and R&D organizations should operate to enable this collaboration.

3. Case context and research process

This work was carried out within the international research projects *Varies* (Variability in Safety-Critical Embedded Systems) [12] and *Promes* (Process Models for Engineering of Embedded Systems) [13]. The case company operates in the automation systems industry. The company offers automation and information management application networks and systems, intelligent field control solutions, and support and maintenance services. The case focuses on the automation system product sector and includes the upgrade and audit service. Typically, the customer-specific, tailored installation of the system is

based on a generic product platform, and a new version of this product platform is released annually. Automation system vendors are also using HW and SW COTS components in their systems, for instance, third-party operating systems (e.g. Windows). Therefore, automation systems are dependent on, for instance, the technology roadmaps of operating system providers. The (generic) main sub-systems in an automation system include: Control Room, Engineering Tools, Information Management and Process Controllers.

Engineering tools are used to configure the automation system so as to fit the customer's context. This includes, for instance, the development of process applications and related views. Automation systems have a long life and they need to be analyzed, maintained and updated, if necessary. Therefore, the case company offers, for instance, upgrade and audit services to keep the customers' automation systems up-to-date. Each update will be analyzed individually so as to find the optimal solution for the customer based on the customer's business needs. Service operation is highly distributed since the case company has over 100 sales and customer service units in 38 countries serving customers representing various industrial segments in Europe, Asia, America, Africa and Australia.

Because of the demands of customer-specific tailoring, there are many customer-specific configurations (i.e. the customer-specific variants of an automation system) in the field containing sub-systems from different platform releases (versions). Therefore, the Service organization (the system provider) needs to track each customer configuration of an automation system and detect what maintenance, optimization, upgrades are possible for each customer to keep the customer's automation solutions running optimally.

Case company aims at better understand collaboration between Service organization and R&D organization. For other companies and research institutes this research provides a descriptive case study how the collaboration between Service and R&D organizations have been established in a two example service case (upgrade and audit cases). Therefore, the research approach is bottom-up. These cases were selected into this study since the company personnel that work in this research project have in-depth knowledge about these services. We first studied these two service processes and then analyzed what kinds of activities can be found to enable the transparency between service and R&D organizations in these cases. We selected this approach since each industrial service seems to have its own needs for collaboration and therefore you first need to understand the service process itself. We have

adapted the approach defined by Charalampidou et al. [14] as a frame for process descriptions. The research has been done as follows:

1. Upgrade-service process description was composed using company interviews and workshops (case 1).
2. Audit-service process description was composed using company interviews and workshops (case 2).
3. Case analysis was performed that combined case 1 and 2 and additional interviews/workshops were held to understand service/R&D collaboration behind the service processes. Two persons that work in service-R&D interface in case 1 and case 2 were interviewed and the results were discussed.
4. Finally, the results of the case 1, case 2 and case analysis were reviewed and modified by the representatives of case company.

4. Industrial cases

Industrial automation systems are used in various industrial segments, such as power generation, water management and pulp and paper production. The systems comprise HW and SW sub-systems that are in-house developed or COTS (Commercial Off-The-Shelf) components. Since these systems have a long lifetime, the automation system providers offer different kinds of industrial services for their customers in order to keep their automation systems running smoothly.

In this article, we present two cases related to the industrial services that both are the sub-processes of the maintenance main process. The first is Upgrade-service and the second is Audit-service. These cases represent process presentations that have been created in cooperation with the case company in order to document and systematize their service processes. These process descriptions have

been utilized in order to identify the interfaces between service and R&D organizations.

4.1 Case 1: Upgrade-service

This section presents the Upgrade-service process (Fig. 1). Upgrade-service is a service that will be provided for a customer to keep their automation systems up and running. The detailed description and demonstration of Upgrade-service process has been presented in [15]. Phases are divided into activities that represent collections of tasks that will be carried out by the workers (e.g. Service Manager). One worker has the responsibility (author) for the activity, and other workers work as contributors. Activities create and use artefacts that will be retrieved from or stored in tools (information systems).

The upgrade service process is divided into six activities. The first four, form the Upgrade Planning process. The last two represent subsequent steps, as the implementation of upgrade and subsequent follow up. This case focuses to Upgrade planning-phase of the Upgrade-service process. The process contains a sequence of activities to keep the presentation simple, even though in real-life, parallelism and loops/iterations are also possible. For instance, new customer needs may emerge during price negotiations that will be investigated in a new upgrade planning iteration.

“Identify upgrade needs” activity:

The process starts with the identification of upgrade needs. The input for an upgrade need may come from various sources, for instance, directly from customer, from a service engineer working on-site at the customer’s premises, from component end-of-life notification, etc. The Service Manager is responsible for collecting and documenting upgrade needs originating from internal or external sources.

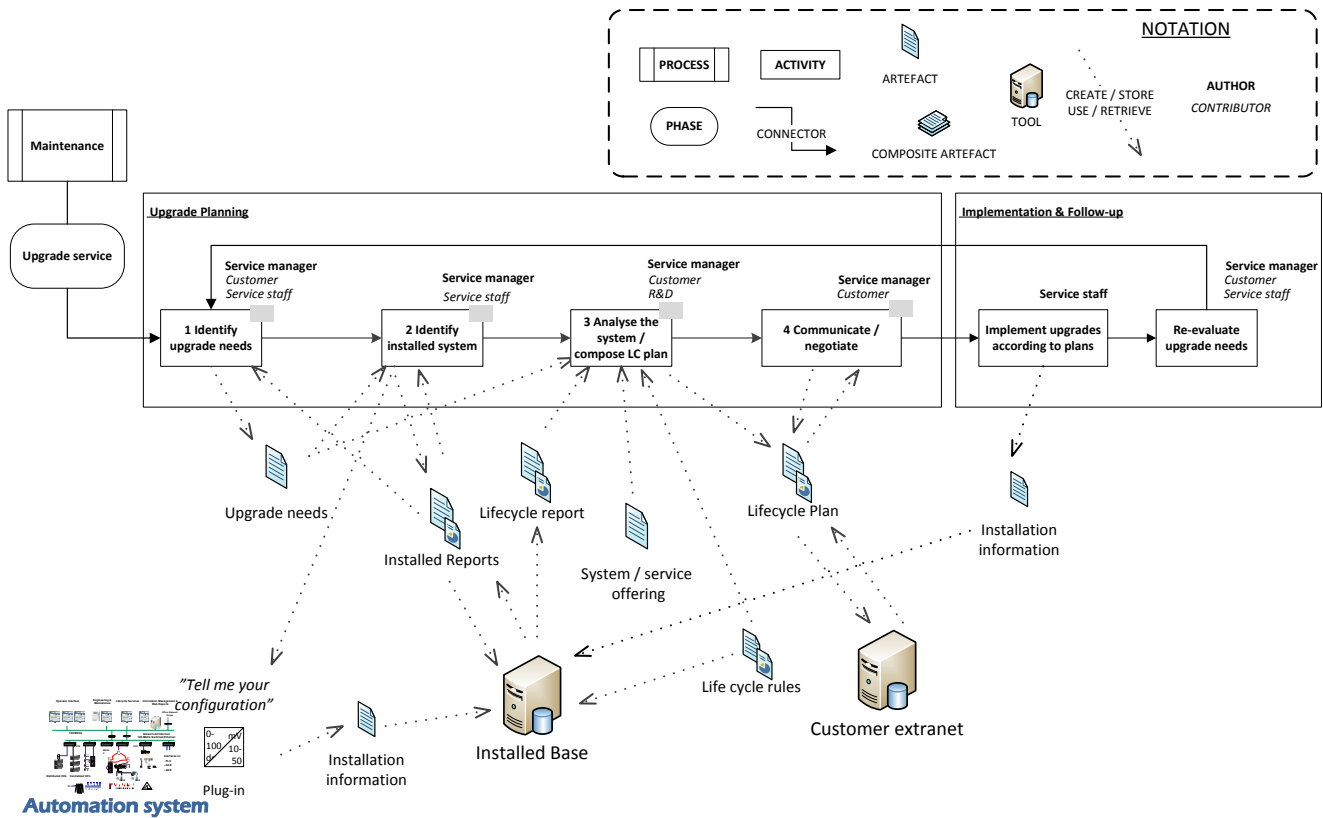


Fig. 1 Description of the Upgrade Planning Process.

“Identify installed system” activity:

The service manager is responsible for carrying out “Identify installed system” activity. In this activity, the customer’s automation system configuration information (i.e. customer-specific installed report) is retrieved from the InstalledBase tool. The information is collected automatically from the automation system (automatically via a network connection with the customer’s automation system) and manually by a site visit, if needed. The updated information is stored in the InstalledBase tool.

Analyze the system/compose LC (lifecycle) plan” activity:

In the “Analyze the system/compose LC (lifecycle) plan” activity service manager is responsible for analyzing the instant and future upgrade needs for the customer’s automation system. The InstalledBase tool contains lifecycle plan functionality. This means that the tool contains some lifecycle rules related to the automation systems. The lifecycle rules are composed by a product manager who works in service interface working in collaboration with R&D organization. The service manager generates a lifecycle report from the InstalledBase tool and starts to modify it based on negotiations with the customer.

“Negotiations” activity:

In the “Negotiations” activity, the service manager modifies the lifecycle plan based upon the maintenance budgets and downtime schedules of the customer. Customer extranet is the common medium for vendor and customer to exchange lifecycle plans and other material. The final lifecycle plan presents the life cycle of each part of the system, illustrating for a single customer what needs to be upgraded and when, and at what point in time a larger migration might be needed. The plan supports the customer in preparing themselves for the updates, for instance by predicting costs, schedules for downtimes, rationale for management, etc. Based on the negotiations and offer, the upgrade implementation starts according to contract. Additionally, the Service Manager is responsible for periodically re-evaluating the upgrade needs.

4.2 Case 2: Audit–service

This section presents the Audit-service process (Fig. 2). Audit-service is used to determine the status of the automation system or equipment. Systematic practices/process and tools to collect the information allow repeatable and high-quality service that forms basis for subsequent services. Audit-service might launch, for instance, upgrade, optimizations, training –services. Again,

as in Upgrade-service-case process description, phases are divided into activities that represent collections of tasks that will be carried out by the workers (e.g. Service Manager). One worker has the responsibility (author) for the activity, and other workers work as contributors. Activities create and use artefacts that will be retrieved from or stored in tools (information systems). The Audit-service process is divided into five activities.

Plan audit -activity:

This activity is used to identify, agree and document scope and needs for audit. This enables systematic audit. The planning starts when there are a demand for service or e.g. service agreement states that the audit will be done periodically. Service staff creates audit plan with the customer that contains information about: scope/needs for

audit, customer contact/team, customer’s arrangements to ensure successful audit (availability of key persons during audit, data analysis and reporting/presentation, visits, remote connections, safety/security), schedule, resources and reporting/presentation practices, etc. Furthermore, service staff documents the audit plan and makes it visible for customer.

Office Research -activity:

The purpose of Office Research is to carry out audit activities that can be done remotely. In this activity service staff collects remote diagnostics according to audit checklist. They further collect information about customer-specific product installation. The output of the activity is the data that is ready for data analysis.

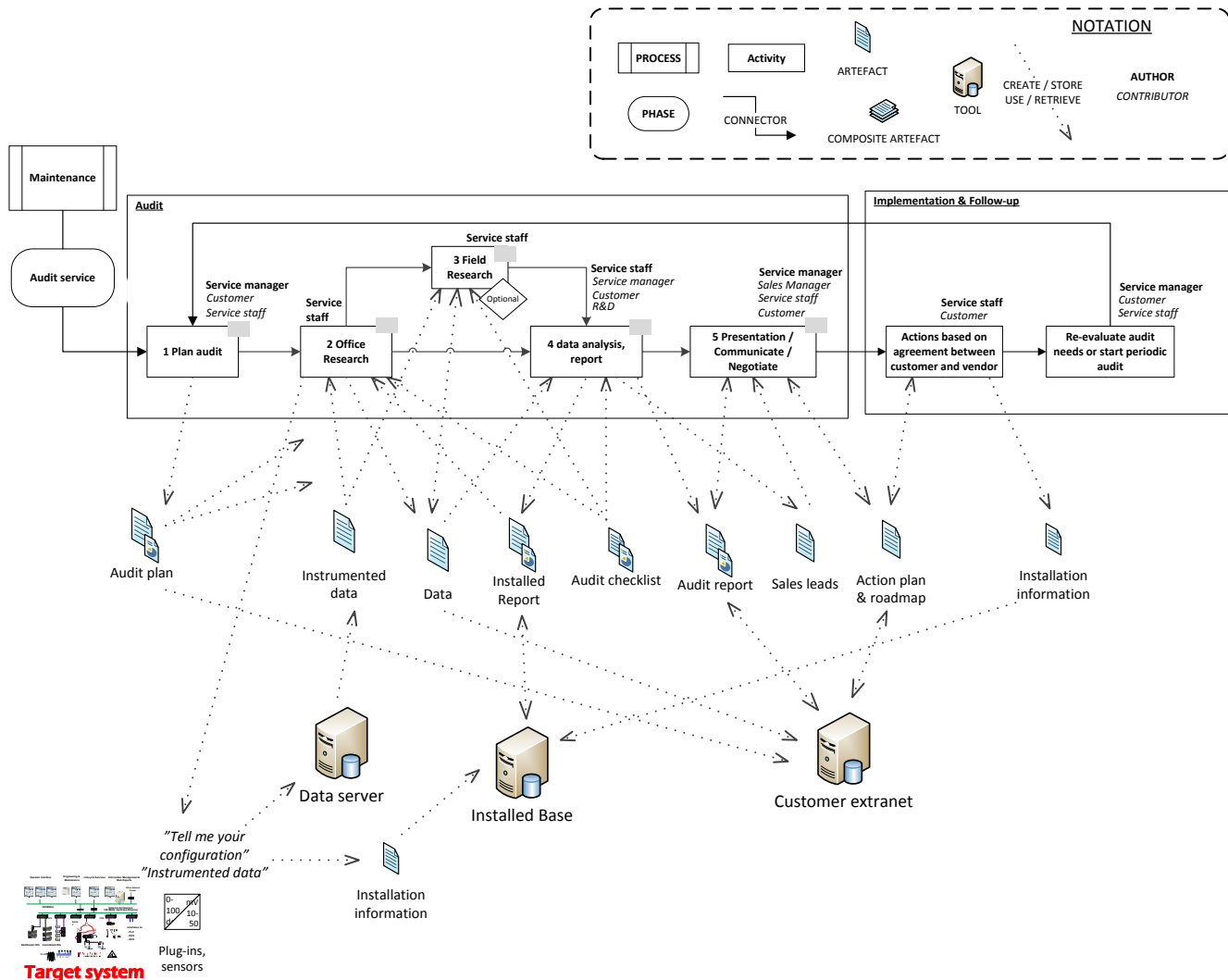


Fig. 2 Description of the Audit Process.

Field research –activity (optional):

The purpose of Field Research is to acquire supplementary information/data during site visits. This activity is optional if Office research–activity is not sufficient. In this activity, Service staff carries out field research tasks according to product-specific checklists (check instruments, get info about maintenance, training needs, remarks concerning configuration, visual check, check the function of the product, corrosion, etc.). Furthermore, staff collects additional installation information from the customer premises (customer-specific product installation), if needed.

Data analysis/report –activity:

Purpose of Data analysis/Report is to analyze collected data and prepare a report that can be communicated with the customer. Data analysis –task analyses audit data and observations. Service staff utilize audit checklist and consult R&D in analysis, if needed. Depending upon the audit, the analysis may contain e.g.: maintenance, part or product obsolescence, replacements, inventory, needs for training, etc. During the analysis customer should prepare time and contacts to answer questions that may arise concerning audit data. Service staff and manager defined recommendations based upon the audit. The Service Manager identifies sales leads related to the audit results. In addition, staff will update installation information into InstalledBase if discrepancies have been observed. The audit report will contain an introduction, definition of scope, results, along with conclusions and recommendations. The report will be reviewed internally and stored into the Customer Extranet and the Customer will be informed (well in advance, in order to allow time for customer to check the report).

Presentation/communicate/negotiations–activity:

This activity presents results to the key stakeholders and agrees future actions/roadmaps. The Service Manager agrees with the customer the time and participants of result presentation event. The results will be presented and discussed. The Service Manager negotiates about the recommendations and defines actions/roadmaps based on recommendations (first step towards price and content negotiations).

5. Case analysis

Integrated service/product development has been studied a lot. However, there is less information available how in

practice the needs of the Service organization could be taken into account during product development. What kind of service/R&D collaboration could improve the quality and lead time of the industrial services? Target is not to describe service development process but try to understand and collect industrial best practices that increase service/R&D collaboration and transparency so that customers can be better and faster serviced. Naturally these practices are highly service dependent since each service need different issues from R&D organization. During the interviews, it become obvious that already on product platform Business Planning phase there has to be analysis activity how new proposed features of the system will be supported by services and what kind of effects there are for different services (e.g. compatibility). Therefore, already in system business planning phase one should consider technical support, product/technology lifecycle and version compatibility issues from service viewpoint before the implementation starts.

Based on cases above the following service/R&D collaboration practices were identified. Basically both cases highlight communication and information transparency between the organizational units.

5.1 Case 1: collaboration related to Upgrade –service

In case 1 there was a nominated person who works in service/R&D interface, i.e. Product Manager who works in Service interface (Fig. 3). This person defines and updates life-cycle rules document that contains information e.g.:

- how long each technology will be supported. In other words, e.g. how long the particular version of each operating system (OS) will be supported (product & service/security packs), along with considerations of if there is any possibility of extended support).
- hardware – software compatibility (e.g. OS version vs. individual workstations)
- compatibility information showing how different sub-systems are compatible with each other (compatible, compatibility restrictions, not compatible).
- other rules or checklists containing what needs to be considered when conducting upgrades (conversions of file formats, etc.)

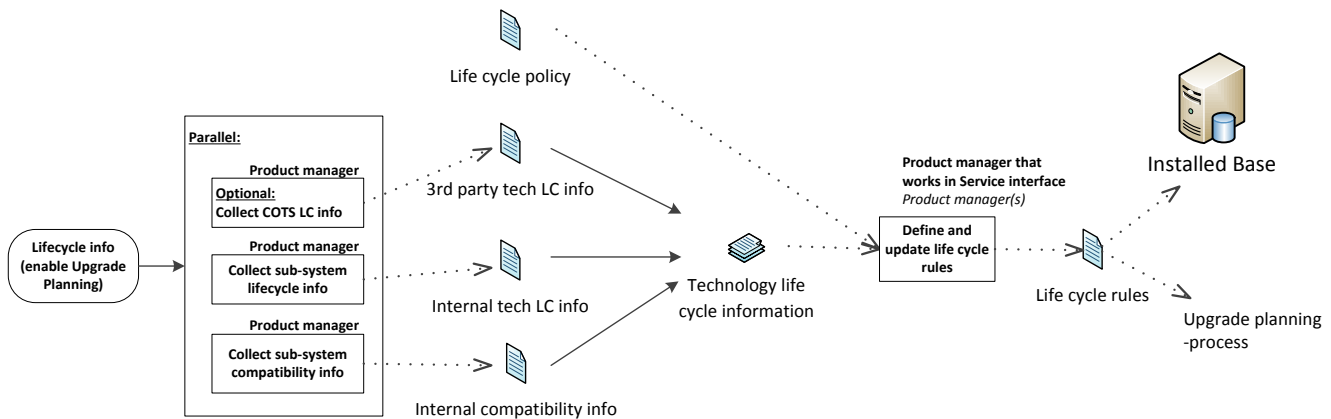


Fig. 3 Collect lifecycle rules -process.

The rules are used by the Service function in order to understand the lifecycle effects to the system. For instance, in Upgrade Planning -process in upgrade analysis -activity this information is used to compose life cycle plans for customers. Product manager that works in Service interface coordinates the composition of lifecycle rules. These rules originate from internal and external sources. External information is collected from third-party system providers (COTS providers). This information comes, for instance, from operating system providers (a roadmap that shows how long operating system versions will be supported). Internal lifecycle information originates from R&D (product creation and technology research functions). Internal lifecycle information defines in-house developed automation system components and their support policy. Furthermore, lifecycle information about system dependencies is also important (compatibility information). Dependency information shows the dependencies between sub-systems and components so as to detect how changes in one sub-system may escalate to other sub-systems in a customer's configuration. Finally, rules are also affected by a company's overall lifecycle policy (i.e. the policy on how long (and how) the company decides to support the systems). Some of these rules are implemented into the InstalledBase tool that partly automates the generation of lifecycle plan. However, since every customer tends to be unique some rules need to be applied manually depending on the upgrade needs.

Based on this case we could compose a task list for the Product Manager who works in the service interface. Product manager's task is to increase and facilitate communication between the R&D and Service organizations (collaboration between organizational units):

1. Coordinates the collection, maintenance and documentation of lifecycle rules in cooperation with R&D to support upgrade planning.
2. Communicates to R&D how they should prepare for lifecycle issues (how R&D should take into account service needs?).
3. Defines the lifecycle policy with company management.
4. Coordinates that Service Managers are creating lifecycle plans for their customers. The objective is that there are as many lifecycle plans as possible (every customer is a business possibility).
5. Participates to the lifecycle support decision making together with R&D (e.g. replacement/spare part decisions, compatibility between platform releases). For instance:
 - decisions concerning how long the company provides support for different technologies/components. Decisions what technologies will be used (smaller changes/more significant changes). Service organization will make the decision (cooperation with R&D).
 - decisions about the compatibility. Service provides needs/requirements for compatibility (based on effects to service business). R&D tells what is possible => needs and possibilities are combined so that optimal compatibility is possible for upgrade business (service organization makes the decision).
 - determines the volume/quantity components there are in field (check from InstalledBase) => effects to the content of next platform release and what support are needed from service viewpoint.

5.2 Case 2: Collaboration related to Audit –service

In case 2, the Service staff utilizes audit checklists that have been prepared collaboratively by Service and R&D, and consults R&D in the audit analysis, if required. The training team that works in the Service organization is responsible for the coordination of the collection and maintenance of the audit checklists (Fig. 4). The checklists are to be composed and maintained in cooperation with R&D. Checklists are product-specific since different issues need to be checked depending on product type. Furthermore, checklists require constant updates as the product platforms evolve, e.g. one needs to check different issues from products of different age.

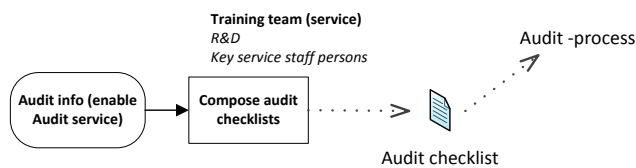


Fig. 4 Compose audit checklist -process.

6. Discussion and conclusions

The importance of industrial services has increased and there needs to be systematic practices/processes to support service and product development. This has been indicated also in other studies, e.g. in [1, 2]. However, there is less information available concerning how in practice the needs of the Service organization could be taken into account during product development. What kind of service/R&D collaboration could improve the quality and lead time of the industrial services? In this article, objective is not to describe service development process but rather to try to understand and collect industrial best practices that increase the collaboration and transparency between service and R&D organizations so that customers can be better and faster serviced.

This article aims to discuss the collaboration and transparency of Service and R&D organizations using two cases that give practical examples about the collaboration, i.e. *what the collaboration and transparency between Service and R&D organizations means in real-life industrial environment*. Furthermore, the article reports what kind of solutions the case company uses to realize the collaboration.

The article shows that in case company service needs were taken into account already in business planning phase of the product development process. Furthermore, there were roles and teams that worked between service and R&D organizations to facilitate the interaction between the

organizations. The approach has some similarities to the solution that is presented in [10]. Similarly their case study indicated that there were need to have units that worked in between the organizations that enabled the interaction.

Based on this research, it is possible to better understand interfaces and needs between Service and R&D organizations. With this information it is possible to begin to improve the collaboration practices and solutions in case company. This research provides for other companies and research institutes that work with industrial companies the practical real-life cases how Service and R&D organizations collaborate. This research is based on bottom-up approach studying two cases and therefore the results are limited since the collaboration is service dependent. This study does not try to explain why the case company has ended up with these practices and solutions, nor that these practices are directly applicable to other companies. However, we described the case in fairly detailed context in section 3 and Service processes in section 4. Therefore, this article provides for industrial companies a good ground to compare their operational environment with the one presented in this article and apply the collaboration practices when appropriate and applicable. For us, this study creates a basis for further research to study the collaboration needs of the other industrial services – for instance such as preventive maintenance services, optimization services, security assessment services.

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