LAPPEENRANTA UNIVERSITY OF TECHNOLOGY
School of Industrial Engineering and Management
Department of Software Engineering and Information Management

A FRAMEWORK FOR IT SERVICE MANAGEMENT INTEGRATION

Examiners: Professor Kari Smolander
MSc Jori Kanerva

Supervisor: MSc Jori Kanerva

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Jussi Saukkonen

ABSTRACT

Lappeenranta University of Technology
School of Industrial Engineering and Management
Department of Software Engineering and Information Management

Jussi Saukkonen

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Examiners: Professor Kari Smolander
MSc Jori Kanerva

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The objective of this Master's Thesis is to find out best practices for IT service management integration. Integration in this context means process integration between an IT organization and an integration partner. For observing the objective, two different perspectives are assigned: process and technology. The thesis consists of theory, framework, implementation, and analysis parts. The first part introduces common methodology of IT service management and enterprise integration. The second part presents an integration framework for ITSM integration. The third part illustrates how the framework is used and the last part analyses the framework.

The major results of this thesis were the framework architecture, the framework tools, the implementation model, the testing model, and the deployment model for ITSM integration. As a fundamental best practice, the framework contained a four-division structure between architecture, process, data, and technology. This architecture provides a baseline for ITSM integration design, implementation and testing.

TIIVISTELMÄ

Lappeenrannan teknillinen yliopisto
Tuotantotalouden tiedekunta
Ohjelmistotuotannon ja tiedonhallinan osasto

Jussi Saukkonen

Diplomityö

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Hakusanat: IT-palvelunhallinta, ITIL, integraatio, prosessi, arkkitehtuuri

Tämän diplomityön tavoitteena on tuoda esille IT-palvelunhallinnan integraatioiden parhaita käytäntöjä. Integraatiolla tarkoitetaan tässä yhteydessä IT-organisaation ja integraatiokumppanin välistä prosessi-integraatiota. Työssä on valittu kaksi näkökulmaa tavoitteen tutkimiseksi: prosessi- ja teknologianäkökulma, jonka lisäksi diplomityö on jaettu teoria-, viitekehys-, toteutus- ja analyysi-osioihin. Työn ensimmäinen osa esittelee IT-palvelunhallinnan ja yritysintegraatioiden yleistä metodologiaa. Toinen osa keskittyy kuvaamaan työn tuloksena syntyneen IT-palvelunhallinan integraatioiden viitekehyksen. Kolmannessa osassa annetaan esimerkkejä viitekehyksen käytöstä ja neljännessä osassa analysoidaan viitekehystä.

Työn tärkeimmät tulokset olivat viitekehyksen arkkitehtuuri, viitekehyksen työkalut, toteutusmalli, testausmalli ja käyttöönottomalli IT-palvelunhallinnan integraatioille. Tärkeimpänä parhaana käytäntönä nousi esille integraatioiden nelikenttä, joka koostui arkkitehtuuri-, prosessi-, data- ja teknologiaosasta. Tämä arkkitehtuuri kuvaa perusrakenteen ja lähtötason integraatioiden suunnittelulle, toteutukselle ja testaukselle.

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ABBREVIATIONS

AOP	Aspect-Oriented Programming
API	Application Programming Interface
B2Bi	Business-to-Business Integration
BAM	Business Activity Monitoring
BI	Business Intelligence
BPEL	Business Process Execution Language
BPM	Business Process Management
BPMN	Business Process Modeling Notation
CMMI	Capability Maturity Model Integration
CSI	Continuous Service Improvement
CSV	Comma Separated Value
EA	Enterprise Architecture
EAI	Enterprise Application Integration
EDI	Electronic Data Interchange
EI	Enterprise Integration
ERP	Enterprise Resource Planning
ESB	Enterprise Service Bus
ETL	Extract-Transform-Load
FTP	File Transfer Protocol
HTTP	Hypertext Transfer Protocol
HTTPS	Hypertext Transfer Protocol Secure
ICT	Information and Communication Technology
ITIL	Information Technology Infrastructure Library
ITM	Information Technology Management
ITSM	Information Technology Service Management
itSMF	IT Service Management Forum
JDBC	Java Database Connectivity
JSON	JavaScript Object Notation
MOM	Message-Oriented Middleware
OASIS	Organization for the Advancement of Structured Information Standards
ODBC	Open Database Connectivity
OLA	Operational Level Agreement
OMG	Object Management Group
PaaS	Platform as a Service
REST	REpresentational State Transfer
SaaS	Software as a Service
SLA	Service Level Agreement
SLM	Service Level Management
SOA	Service Oriented Architecture
SOAP	Simple Object Access Protocol
SOI	Service Oriented Integration
SSL	Secure Sockets Layer
TOGAF	The Open Group Architecture Framework
TLS	Transport Layer Security
UAT	User Acceptance Test
UDDI	Universal Description Discovery and Integration

UI	User Interface
W3C	World Wide Web Consortium
WSBPEL	Web Services Business Process Execution Language
WSDL	Web Service Definition Language
XML	Extensible Markup Language

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1. INTRODUCTION

1.1. Background

During recent decades organizations have improved automation utilizing information and communication technologies (ICT). This change has shifted people from manufacturing industries to service industries (Chesbrough & Spohrer 2006, 36). Nowadays, Information Technology (IT) is not anymore just hardware, systems, software, and PCs. IT can be seen more of a services domain. (van Bon et al. 2007b, 14)

IT Service Management (ITSM) is a part of service sciences which is a mixture of computer science, operations research, industrial engineering, business strategy, management sciences, social and cognitive sciences, and organizational theory (Galup et al. 2009, 124). The main purpose of ITSM is to align business requirements to IT services and deliver services to organizations (Deutscher & Felden 2010, 167). ITSM was earlier perceived as service-oriented Information Technology Management (ITM) which focused on infrastructure management from process point of view. However, this thinking has changed towards process and customer-orientation during the last decade. Now, the term ITSM has established its position as a distinct discipline and its main objective is to contribute quality to IT services. (van Bon et al. 2007b, 17)

Frameworks and standards provide a baseline for ITSM implementations. One of the best known frameworks is ITIL. It originally stood for the Information Technology Infrastructure Library but this definition can no longer be found in the new ITIL books since the current scope of ITIL is not anymore limited to the infrastructure. ITIL provides both best practices for ITSM and also a set of integrated processes (van Bon et al. 2008, 31). In addition to ITIL, there are other important ITSM frameworks such as Capability Maturity Model Integration (CMMI), COBIT and Six Sigma. CMMI integrates different software engineering maturity models into one framework. COBIT organizes IT capabilities, performance and risks into a unified structure which helps in evaluation, implementation and understanding. Six Sigma aims at improving IT process capabilities and decreasing process variation with the use of measurement tools. The first international standard of ITSM, ISO 20000, provides an integrated process approach for delivering managed services to both business and customers (van Bon et al. 2008, 31-32). Each framework emphasizes different aspects, even though they can be used jointly.

ITSM processes can be integrated through different perspectives. One perspective is to integrate an ITSM process with other ITSM processes. In fact, this is what ITIL tends to do. Another perspective, which is also supported by ITIL, is to integrate ITSM processes within an organization. The target of this perspective is to change the ways people are working. More technical integration perspective is Enterprise Integration (EI) which supports the expansion of ITSM processes over the organizational boundaries. This kind of approach has been paid less attention. Therefore, the EI approach for ITSM process integration was chosen to this thesis to be observed more thoroughly.

In addition to the theoretical need, this thesis has also a practical motivator. The integration problems faced in the everyday work at Sofigate Oy have created a real need for general integration model that guides through the ITSM process integration projects from design to deployment, and provides best practices from process and technology wise.

Sofigate Oy was founded in 2003 and it is specialized in ICT management and development providing different types of ICT management services. The services vary from ICT expert and development services to full services which provide comprehensive ICT management on a turnkey basis. The company consists of over 100 employees and the turnover in 2012 was 16.1 million Euros. (Sofigate 2013)

1.2. Problem Description and Scope

This thesis targets to find out best practices for the communication between an IT organization and an integration partner. More specifically, this communication takes place between ITSM systems and it can be referred to integration. However, the term integration in this context could be easily mixed up with the system integration. Therefore the word “communication” illustrates the scope better.

The need for integration has existed since the development of enterprise systems. Today, this need still remains and according to Zhang et al. (2009) modern organizations have built up their IT relying on distributed applications, tools, and systems. These complex environments comprise of dispersed resources which require collaboration among each other.

A lot of studies have been made focusing on implementation and integration of ITSM processes in organizations. However, these studies mainly focus on the business and process point of view and a clear technical perspective is missing. On the other hand, other studies have been exploring technical requirements for ITSM process integrations inside organizations. These studies provide good technical knowledge about the technology and requirements but the higher level picture is missing. This thesis aims to fill this gap by observing ITSM process integration from both business and technology aspects.

Specific ITSM processes, for example incident and change management processes, are frequently extended outside organizational boundaries. This means that the external integration partner is a part of the end-to-end process. A good example is a service desk function which is often outsourced. Therefore, a basic scenario would be to build up integration for incident management between IT organization's ITSM system and integration partner's ITSM system. This kind of integration automates the communication and reduces manual work. Additionally, the integration provides more effective reporting and monitoring capabilities from the IT organization perspective. This is because tickets are recorded into database with timestamp, categorization and other relevant information which can be later used for reporting.

As a limitation, this thesis focuses only on ticket integrations between an IT organization and an external integration partner using incident management as a reference solution. The word ticket integration in this context refers to integrations which are transactional by nature and consist of nearly real-time messages. To give an example, incidents, service requests, change requests and problems can be considered as tickets in the ITIL context. One more limitation is that this thesis does not focus on Application Programming Interface (API) development in a code level since the focus is more on architectural level.

Derived from the previous discussion, this thesis consists of two main research questions. The main research questions are presented as follows:

1. *What are the best practices for integrating an ITSM process with an integration partner?*
2. *How integration interfaces should be built to support the interoperability and the ease at maintenance?*

The thesis framework illustrates the focus areas and interdependency between the research questions. The framework is presented in the figure 1.

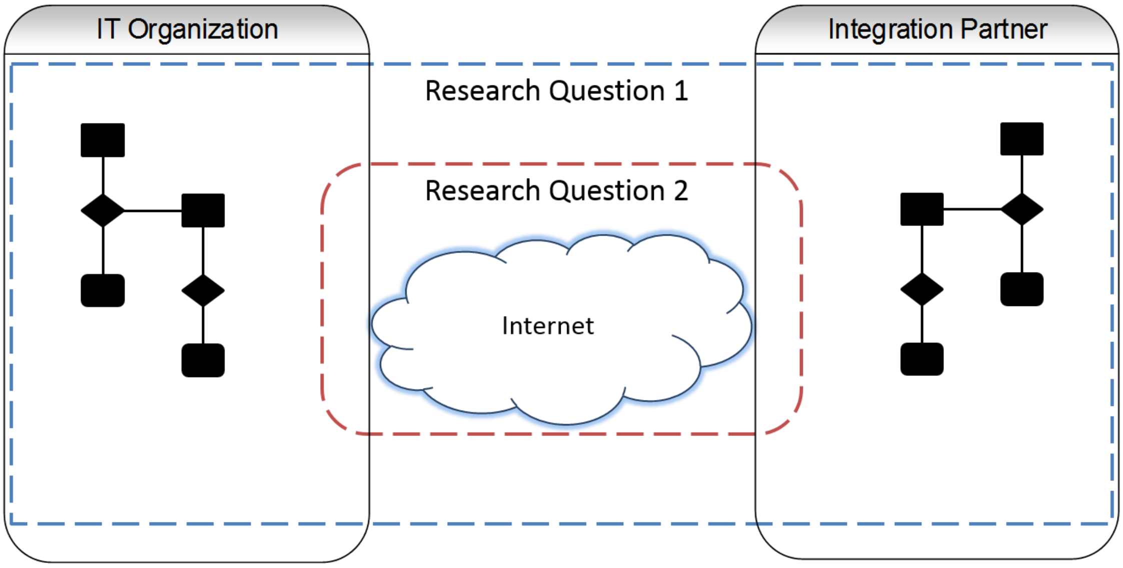

Figure 1: Thesis Framework

The purpose of the first research question is to address good and generally accepted ways of building integrations between IT organizations and integration partners. Integration in this context means automatic message exchange between communication interfaces over the Internet. More specifically, the research question examines an end-to-end integration process from IT organization to the integration partner. The second research question looks integrations from more technical perspective. It focuses on finding the best ways of designing and implementing integration interfaces with interoperability in mind. It also observes recommended techniques and methods for integration.

1.3. Methods

This thesis is divided into four parts which are theory, framework, implementation and analysis. The theory part introduces common methodology of ITSM and EI. The framework part summarizes the findings from theory part and combines them with researcher's practical knowledge. As a result a generic framework is created which describes integration best practices and provides different viewpoints that cover integrations comprehensively. This newly created framework is then used to design an ITSM process integration. This step represents the implementation part and takes the theory into practice. The final part of the thesis analyzes the framework outcome. These previously discussed parts are presented in the figure 2 as a process.

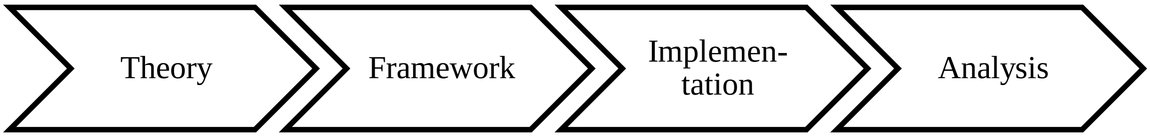

Figure 2: Thesis Process

This process is organized so that it can be classified to the action research. Crowther & Lancaster (2012) describe action research as an approach that solves practical problems with the help of researcher's involvement. Following characteristics give a better insight of this approach: problem-centered, participative, cyclical, co-operative, and professionally developing. Most notably, a researcher implements solutions to outlined problems and analyzes outcomes. The process is cyclical which means that the researcher continuously improves the solution based on the feedback and evaluations. Furthermore, action research focuses on developing individuals instead of scientific knowledge.

1.4. Structure of the Thesis

The structure of this thesis consists of seven chapters. The first chapter introduces the background, the research problem and the methods used in this thesis. Generally, the first chapter gives an overall picture what this thesis is all about. The remaining chapters are categorized to theory, practice, and review.

The second and the third chapter are theory chapters. The second chapter gives an overview of ITSM and related concepts. Furthermore, its purpose is to give background information for the first research question. In regard to the scope of the thesis, the second chapter focuses only on the incident management. Therefore, all ITSM processes are not comprehensively dealt with. The third chapter presents technical methodology needed to extensively answer to the second research question. More precisely, the third chapter introduces EI, Service-Oriented Architecture (SOA) and data integration. In addition, the chapter discusses about the history of EI and the current state-of-the-art interoperability recommendations in the EI landscape.

The chapters four and five are related to the integration framework and provide practical knowledge about ITSM process integrations. The purpose of the fourth chapter is to observe ITSM process integrations from both process and technical perspective. At the same time it presents researcher's practical experiences about ITSM integrations. The fifth chapter focuses on describing the integration framework. It presents the framework architecture, implementation, testing and deployment models. After this the chapter demonstrates how the framework tools are used to build an ITSM integration design.

The outcome of the integration framework is analyzed in the chapter six. The chapter evaluates the usefulness of the framework, discusses about benefits gained from the integration framework utilization, and highlights the development areas of the framework.

The seventh chapter concludes the thesis by answering to the research questions. This chapter also presents the found results and evaluates how the results are linked to the theory. After this the chapter discusses about exploitation of results and, finally, ends the discussion with future trends and visions.

2. INTRODUCTION TO IT SERVICE MANAGEMENT

ITSM is about designing, implementing, developing, supporting and managing IT services. The core parts are service itself and service quality which are managed utilizing best practice frameworks and standards, such as ITIL and ISO/IEC 20000.

This chapter begins with introduction of services, and continues describing ITIL framework and ISO 20000 standard. The last part of this chapter drills deeper in ITSM technology aspect and service integration. The chapter combines business and technology from ITSM perspective.

2.1. What Is a Service?

A fundamental part of ITSM is services which create the foundation for different operations and activities. Service contexts, layers and quality are the core attributes that describe services.

Service Definition and Context

A service can have multiple contexts. Following service definitions blur the line between business and technology.

> "A service is a means of delivering value to customers by facilitating outcomes customers want to achieve without the ownership of specific costs and risks." (OGC 2007b, 11)

> "An IT service is a service provided to one or more customers by an IT service provider. An IT service is based on the use of IT and supports the customer's business processes. An IT service is made up from a combination of people, processes and technology and should be defined in a Service Level Agreement." (van Bon et al. 2007b, 19):

> “A service is a unit of solution logic to which service-orientation has been applied to a meaningful extent. It is the application of service-orientation design principles that distinguishes a unit of logic as a service compared to units of logic that may exist solely as objects or components.” (Erl 2008a, 37)

As the different definitions of a service state, usage of the service depends on the context. Table 1 presents IT service contexts derived from the definitions and brings out the objectives of each context.

Table 1: IT Service Contexts

Context	Objective
Business	Value creation
Process	Supporting business processes
Technology	Providing logical functionality

The business context rises up value creation while the technology context sees services as logical components. The process context ties the service to organization’s processes and connects the service as a part of process network. All in all, services have common denominator in spite of the context; someone or something uses them whether it is a human or a computer.

Service Layers

Services are usually seen as larger entities. One example of this is IT device order service. Services of this size can wrap smaller subservices inside them or utilize other underlying services, such as billing or integration services. Therefore size of a service depends on the layer on which the service is examined. For example, if IT device order service is implemented in an ITSM system, it should be examined on business layer as it is business related.

Services follow certain process which contains different steps called activities. The activities should be examined on the process layer. If the service structure is explored even in more detail, one can see that outputs of different activities in the process act as triggers. If this process is implemented in ITSM system, triggers fire execution of certain technical functionalities which can consist of scripts, database field changes, or other changes in the system. In fact, one example of a technical functionality is a web service which can send and receive data from one point to another over the Internet. When the service is inspected from end user point of view to the code level, one can notice that it is not ideal to present all information at once, especially for all different target groups. At this point, service layers come in. One layer is used for presenting information, one for handling process activities, and one for executing technical functionalities.

Service Quality

Without proper quality of services, services could not be valued by business (van Bon et al. 2008, 1). Therefore, quality is more than a result of a technical attribute; it is a relationship with a service consumer (van Bon et al. 2007b, 35).

According to van Bon et al. (2008), following attributes of an IT service can be used to measure quality:

- Availability
- Capacity
- Performance
- Security
- Confidentiality
- Scalability
- Adjustability
- Portability

All of these attributes measure IT service as a component. However, van Bon et al. (2007b) see that a characteristic of modern ITSM is an end-to-end approach which means that service quality is measured at consumer's level and not on component level. Taking this into account in design phase will lead building IT services from customer-oriented aspect instead of technology-oriented aspect. In practice, end-to-end approach means that IT services are measured both at component and end user levels. For example, end users could be asked: How they feel about the service? If the service has worked well at the component level but external factors, such as difficulties in integration, have affected to the end-to-end functioning of the service, then the overall feeling might not be good. Therefore, constant measuring is needed on all the service levels.

Service Level Management (SLM) process defines, monitors, and reports about the objectives of an IT service. SLM provides valuable information for an IT organization and integration partner about current status of the service. It also ensures that actions are taken when they are needed. An agreement that describes targets and responsibilities between IT organization and integration partner is called as Service Level Agreement (SLA). The agreement directs both parties to operate as stated in the agreement. Operational Level Agreement (OLA), on the other hand, is an agreement between integration partner and supporting function of the same organization. The purpose of OLA is to assure that the objectives of supporting activity are aligned with the SLA. (van Bon et al. 2007a, 196; OGC 2007b, 66)

To summarize the service quality discussion, one of the most important indicators of service quality is customer satisfaction. Therefore, the quality of services should be measured all the way from end user to integration partner and vice versa ensuring that the whole service chain is covered. Otherwise, some unexpected downgrades to service levels might appear. The SLM process addresses this need.

2.2. ITIL Best Practice Framework

Service management grew its popularity on 1980s converging business and IT at the same time. Despite the rapid growth, service management suffered from inefficiencies. Inspired by this, UK government presented a document, which later expanded to over 40 books, consisting of guidelines on how to implement service management to support businesses. This collection of books is called ITIL. (OGC 2007d, 3)

ITIL is not a standard although it has gained a status of de facto standard. ITIL is a collection of ITSM best practices that have influenced significantly on the formal standard of ITSM, British Standard 15000. Also the later introduced ISO 20000 standard has absorbed influences from ITIL. (OGC 2007d, 3)

Currently ITIL is in version three but the 2011 edition of the third version can be almost considered as the fourth version. The version three consists of six books which follow the ITIL Service Lifecycle. The development of ITIL takes place collaboratively in IT Service Management Forum (itSMF) (OGC 2007d, 3).

ITIL Service Lifecycle

The heart of ITIL is Service Lifecycle which is presented in figure 3. The Service Lifecycle consists of Service Strategy, Service Design, Service Operation, Service Transition, and Continual Service Improvement (CSI). Each of these ITIL Service Lifecycle parts contains specific processes that support the objectives set for that particular part. (OGC 2007a, 5)

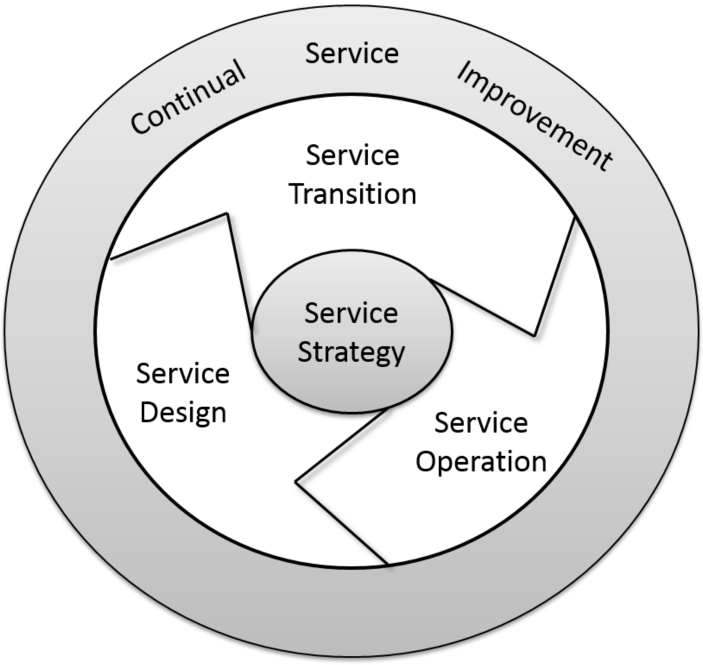

Figure 3: ITIL Service Lifecycle
(Modified from: OGC 2007a, 5)

Service Strategy is the core part of the service lifecycle. It steers other parts and gives strategic guidelines for managing services. Its objective is to find and decide ways to serve customers. Service strategy also covers financial matters and risk management. (OGC 2007d, 11)

The value creation and business alignment are essential objectives of Service Design. It covers principles and methods needed to convert business ideas and business objectives into long-term plans. Service Design supports Service Strategy objectives by concretizing them into to the design. (OGC 2007d, 11)

The purpose of Service Transition is to take care that services are taken into the production use in a controlled manner. Other responsibility of this part is the management of service changes. (OGC 2007e, 7)

Operational level activities are performed at the Service Operation part of the ITIL Service Lifecycle (OGC 2007d, 12). While day-to-day activities are handled in this part, Service Operation is also responsible for efficient execution of processes. Additionally, Service Operation ensures that support functions work properly and services achieve their business objectives. (OGC 2007c, 19)

CSI targets to improve the quality of services throughout an IT organization. CSI aligns IT services to changing business needs by reviewing and analyzing improvement opportunities together with service level outcomes. (OGC 2007a, 7, 14)

Huovinen et al. (2012) have taken a practical way to present the ITIL's Service Lifecycle. The lifecycle is organized into different phases and outcomes which are presented in the figure 4.

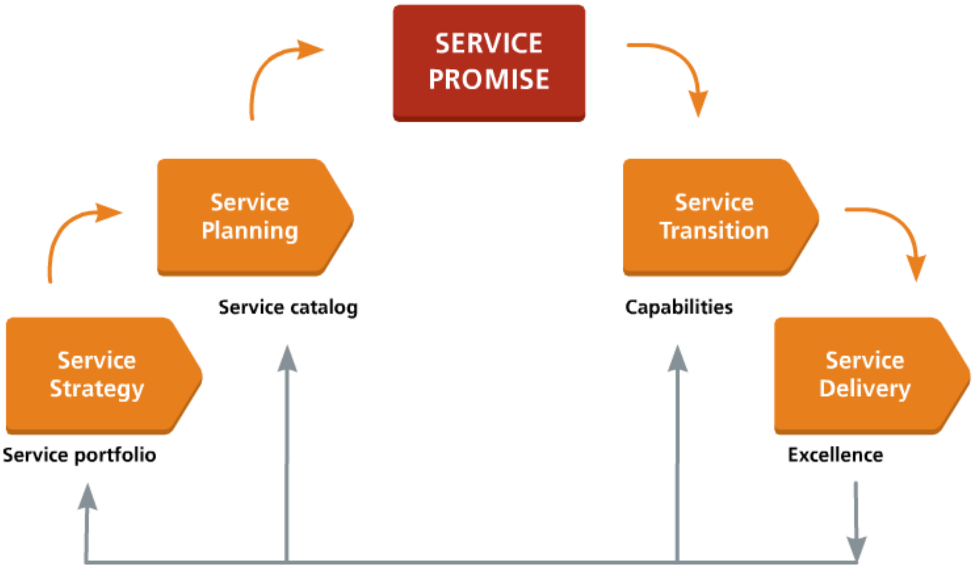

Figure 4: Service Lifecycle Management
(Huovinen et al. 2012, 119)

The lifecycle of services starts from the Service Strategy which defines the service portfolio containing all old, current and new services. The service portfolio aligns business needs to service guidelines. The purpose of the Service Planning phase is to define a service catalog which contains all visible services. In this phase services are planned and a service promise is given. Services require capabilities, which consist of processes, knowledge, tools and basic information, to operate effectively. These are created in the Service Transition phase. Operational excellence is achieved in the Service Delivery phase which aims to fulfill the service promise. Finally, feedback and experiences are needed in order to develop services continuously. (Huovinen et al. 2012, 119)

Incident Management

The Incident Management process belongs to the Service Operation part of the ITIL Service Lifecycle. A typical integration in ITSM system is Incident Management integration as it is basic processes of ITIL. The Incident Management has been chosen to this thesis as a reference process due to its easy to understand structure.

OGC (2007c) defines incident as follows:

> “An unplanned interruption to an IT service or reduction in the quality of an IT service“

As the previous definition illustrates, an incident means disruption of a service. Disruptions should be handled as rapidly as possible in order to restore the service operation at the normal level (OGC 2007c, 46). This is the objective of Incident Management even though the complete process consists of several actions. Figure 5 presents the summarized incident management process from the ITIL point of view.

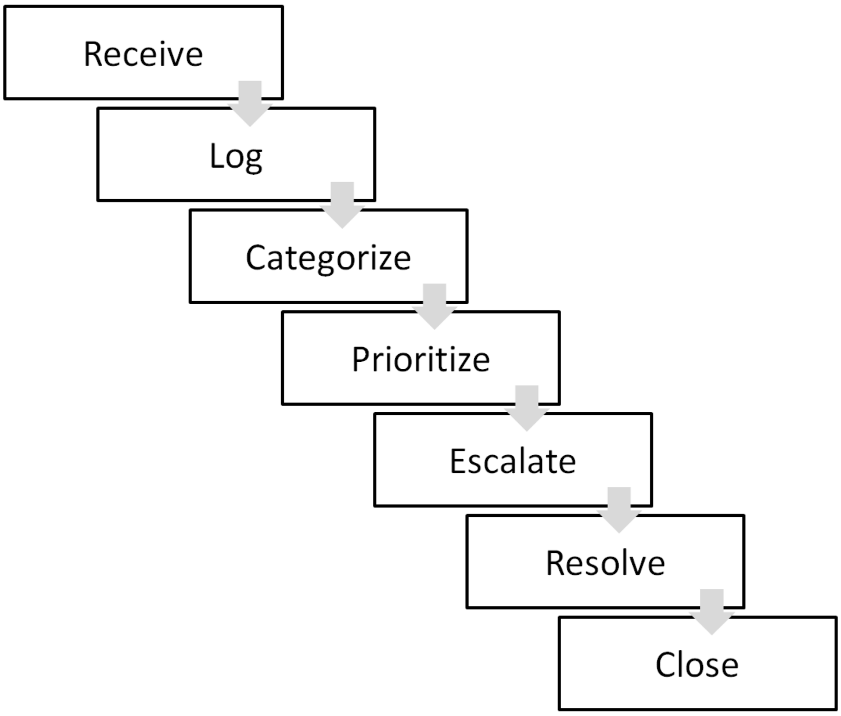

Figure 5: ITIL Incident Management Process
(Modified from: OGC 2007c, 48)

The process is divided into seven steps which illustrate actions from creation to resolution of an incident. The first step is to receive an incident via email, phone, web form, or generated by event management. Event management in this case means that predetermined event triggers the creation of incident, for example in ITSM system. The second step is to log the incident. ITIL states that all incidents should be logged. Usually logging is done in an ITSM system but any other method can be used as long as all incidents are getting logged. The third step is to categorize the incident. The purpose of this step is to help in the assignment and reporting of the incident. Prioritizing is the fourth step which affects to the processing speed of the incident. This means that higher priority incidents are handled prior to lower priority incidents. Escalation is the fifth step which is not necessary if the incident can be resolved by the first level support. The escalation action moves the incident to some specific group or person who has better knowledge and skills to resolve the incident. When the incident is resolved, it should remain active until a user agrees with the resolution. If a user is not satisfied with the resolution, a possibility to reopen the incident should be provided. (OGC 2007c, 48-53)

2.3. ISO/IEC 20000 Standard

ISO 20000 is the first international standard in ITSM. The purpose of the standard is to illustrate the capabilities needed for service quality management in IT sector. The standard ensures that the IT organization has achieved certain level of quality in its services and processes. Even though ISO 20000 provides requirements for both good professional practice and quality, the requirements are meant to be general and not organization-specific. (Clifford 2008, 3-4)

The ISO 20000 standard was released on 15th December 2005. It replaced the older BS 15000 standard which focused on requirements for an ITSM quality management system. In turn, the BS 15000 standard was based on the ISO 9000 standard which provided general processes for organization management. In addition, the early versions of ITIL have been the starting point for ITSM standard development. (Clifford 2008, 5; van Bon et al. 2008, 42-43)

The ISO 20000 standard is comprised of two different parts: Specification and Code of practice. The first part presents the formal requirements needed for certification. The second part provides ITSM best practices and instructions for implementing the requirements presented in the first part. (Clifford 2008, 7-8)

According to Clifford (2008), ISO 20000 introduces four main targets for ITSM system:

- Customer-Focused
- Integrated Processes
- End-to-End Service Management
- Continual Service Improvement

These targets are well aligned with ITIL's best practices and they also illustrate the objective behind ISO 20000. The first target shows that focusing on customer needs is an essential requirement for every ITSM system. This statement can be derived from the following idea chain: Business needs customers to be successful and without customers there is no business. Customers, which are in this case business users, expect to get value from the ITSM system. This value can be best provided by being customer-focused and doing things from customer perspective.

The second target means that processes should be integrated into a larger network and avoid them to work on silos. This is because the integrated process network provides better information flow between the processes (Clifford 2008, 7). The third target, end-to-end service management provides a wider scope to the ITSM process chain. It forces to measure quality of service on a consumer's level. Services need constant evaluation and improvement in order them to stay business aligned. Thus, the fourth target is CSI which fulfills this need.

3. ENTERPRISE INTEGRATION METHODOLOGY

ISO/FDIS 19439 (2005) defines EI as “process of ensuring the interaction between enterprise entities necessary to achieve domain objectives”. Thus, EI can be seen as an umbrella term for integrations and integration architectures within an organization. In fact, EI supports ITSM process integrations by providing methods and architectures for designing and implementing integrations technically. This chapter presents EI methodology used in the ITSM process integrations.

EI can be divided into five fundamental parts which illustrate the structure and design of integrations:

1. Integration Approach (Hohpe & Woolf 2004, 5)
2. Integration Architecture (Lam & Shankararaman 2007, 12)
3. Communication Channel (Hohpe & Woolf 2004, 99; Tähtinen 2005, 53)
4. Communication Interface (Hohpe & Woolf 2004, 463; Spackman & Speaker 2005, 52)
5. Data Transformation (Spackman & Speaker 2005, 29; Tähtinen 2005, 54)

The chapter starts with introducing what has been done regarding to EI and what are the main concepts related to it. Then the chapter continues presenting different parts of EI including integration approaches, integration architectures, communication channels, communication interfaces, and data transformations. Finally, the chapter summarizes the current interoperability recommendations used in the industry.

3.1. Short History of Enterprise Integration

EI has roots in the 1960s when systems were integrated through programmed interfaces. These integrations were point-to-point and the solution logic was implemented using low level programming languages. Shared databases were the next step in the evolution timeline. They provided direct access from different locations to common data. The Electronic Data Interchange (EDI) allowed separate businesses to integrate with each other using predefined and standardized interfaces in the 1970s. The next generation of EI in the late 1980s was Enterprise Resource Planning (ERP). It brought integrated applications together utilizing a single database. In the 1990s, middleware provided a common layer for different applications and databases. At the same time the eXtensible Markup Language (XML) emerged and created a new standard language for web communication. Few years later a new concept called Enterprise Application Integration (EAI) was introduced. EAI enabled integrations among ERP, legacy systems, and web applications. Further, Web services were first introduced in the turn of 21st century in conjunction with the concepts Simple Object Access Protocol (SOAP), Universal Description Discovery and Integration (UDDI), and Web Service Definition Language (WSDL). This historic timeline of EI is visualized in the figure 6. (Singletary 2003, 6; Finkelstein 2006, 421)

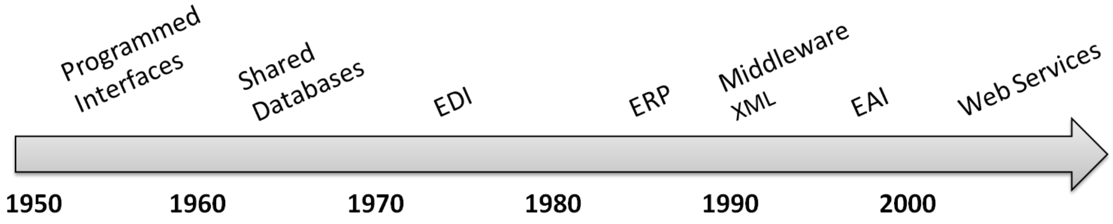

Figure 6: EI Timeline
(Modified from: Singletary 2003, 6)

3.2. Enterprise Integration Concepts

EI is part of Enterprise Architecture (EA) which is the highest level of viewing organization's systems, processes and people. EA is the future vision of organization's strategy for business processes and IT infrastructure (Ross et al. 2006, 9). The objective of EA is to help at managing the complexity and risks that arise when the organization extends (Chen et al. 2008, 648). Huovinen et al. (2012) see EA divided into business architecture, application architecture, information architecture and technology architecture. In this EA model business architecture steers the planning, application architecture connects other parts together, information architecture creates the foundation, and technology architecture stabilizes the development. Even though the EA model is a strategic management tool, the fundamental idea can be adapted to the integration work as well.

EI can be considered as a technical enabler for business process deployment in organizations but also as a connector of different applications from diverse locations (Hohpe & Woolf 2004, 2; Lam & Shankararaman 2004, 40). EI has evolved from technology oriented to business oriented concept. This change has set demands for current EI implementations and according to Tähtinen (2005), well designed EI is agile and open, since EI has to support strategic changes made by the business. In addition, EI should be able to deliver information between different systems, software and people. Cummins (2009) states, that the key drivers towards agile enterprise are task automation, EAI, the Internet, Web services and SOA.

Enterprise Application Integration

The term EAI is closely related to EI. The differences are that EAI takes more technical perspective of viewing things and it is tool-focused. EAI shares data and business processes between different applications and data sources (Linthicum 2000, 3). It connects enterprise's applications together using middleware which is used as an application-independent interface (Ruh et al. 2001, 2).

EAI targets to build up a centralized integration architecture which connects different integration technologies together. There are three main reasons for the rise of EAI within organizations. Firstly, E-commerce has pushed organizations to integrate on the business process level. Secondly, mergers and consolidations of companies have created the need to integrate different platforms and applications. Thirdly, the popularity of ERP packages has increased the need for EAI because ERP solutions do not automatically support integration to other external packaged applications. (Themistocleous 2004, 85; Naveen et al. 2003, 70-71)

Service-oriented Architecture

> "SOA is an architectural style whose goal is to achieve loose coupling among interacting software agents. A service is a unit of work done by a service provider to achieve desired end results for a service consumer." (He 2003)

SOA is a technology architecture model which can be implemented with methods including automation, integration, and modeling. It follows the strategic goals of service-orientation and aims to agile and effective enterprise IT. The solution logic in SOA is encapsulated into services with accessible APIs. (Erl 2008a, 36-37; Cummins 2009, 27)

Erl (2008b) simplifies SOA design principles into eight key aspects:

- Standardized Service Contract
- Service Loose Coupling
- Service Abstraction
- Service Reusability
- Service Autonomy
- Service Statelessness
- Service Discoverability
- Service Composability

Service contracts have important role in service design. They define the objectives and the use of service logic. Service contracts can also be viewed as core architectural components because other SOA principles have impact on their position, design and utilization. A service contract consists of a group of service descriptions: technical and non-technical ones. The technical one refers to the technical interface and non-technical to the service description document. (Erl 2008b, 126-127)

Services usually have relationships to other services, surrounding environment, and service consumers. This linkage is called as service coupling. The aim of service loose coupling is to design services with minimal dependencies on the underlying environment and service consumers. In other words, changes in service logic should affect to service consumers as little as possible. (Erl 2008b, 167-168)

Hiding unnecessary details is the responsibility of service abstraction. Basically, this means that applications should provide only information that is needed by others. Thus, the provided information can be divided into internal and external information. This allows the internal service logic and information to be changed in the future without massive modifications into external information structure. (Erl 2008b, 212)

Service reusability promotes the reuse of service logic. This means that services should be designed to be generic. Furthermore, the services should be able to handle different kind of requests and to support multi-purpose use without changing the service logic. (Erl 2008b, 254-255)

Service autonomy means that services should be able to process their logic independently without external involvement. This capability increases reliability and predictability because the control of the service logic is located in one place. (Erl 2008b, 294-295)

Service statelessness refers to the idea where services should be used when needed rather than continuously. Services should be on passive state when they are not needed and in active state when they are used. This will make services more scalable as proper state management services minimizes the use of resources. (Erl 2008b, 326-327)

Service discoverability aims at providing a service registry which collects all services, their descriptions and other meta information in it. The service registry promotes the services that are already implemented in the enterprise and help developers finding reusable functionalities. Thus, this principle supports the service reusability. (Erl 2008b, 366, 369)

Service composability is a design principle in which the problems are split into smaller problems and then resolved by smaller service units. This means that smaller services together compose the core service which coordinates and orchestrates the use of other services. (Erl 2008b, 389)

3.3. Integration Approach

Lee & Hong (2003) have identified two approaches for EI. The internalization approach is implemented using ERP which means that organization’s business processes are fitted into one multi-module application software. The ERP approach integrates data between organization functions still keeping the data within one software solution. In comparison, the externalization approach utilizes EAI where existing applications are connected together using a common interface layer called middleware. The EAI approach targets to improve and automate organization's overall IT functionality combining plans, methods, and tools for integration.

Tähtinen (2005) sees internal and external integrations differently. The internal integration is referred to EAI due to its role to integrate systems within the organization. Business-to-Business Integration (B2Bi) is considered as the external integration because B2Bi occurs when organization communicates with other organizations. This difference can be justified with different viewpoints. Lee & Hong (2003) observe EI from architecture and business perspective while Tähtinen (2005) uses technical and process perspectives.

According to Hohpe & Woolf (2004), EI approaches can be categorized into six different types. The categorization is based on the experiences from design and implementation projects. Figure 7 shows these different approaches.

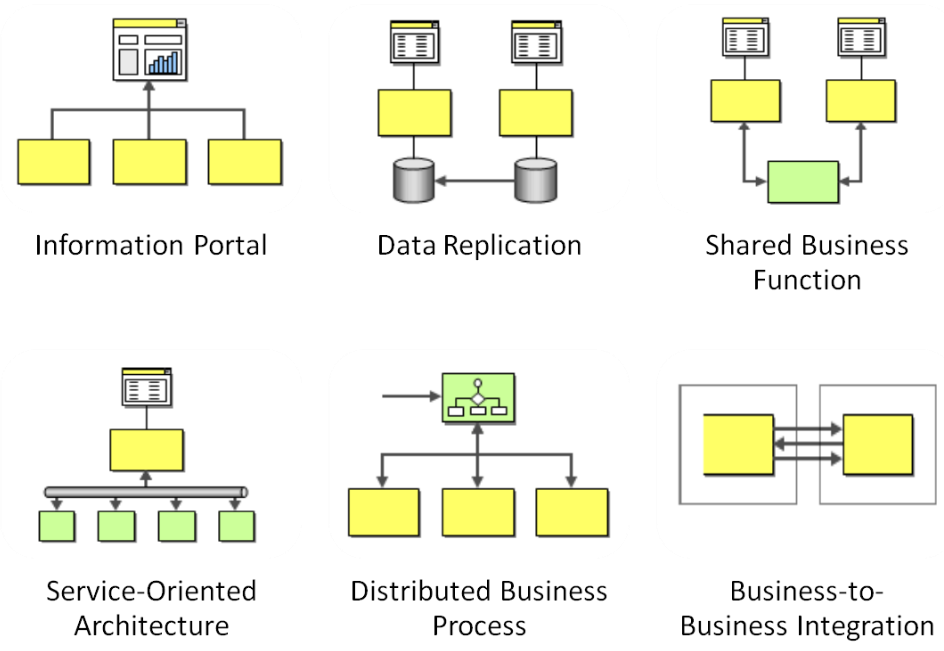
Information Portal
Data Replication
Shared Business Function
Service-Oriented Architecture
Distributed Business Process
Business-to-Business Integration

Figure 7: EI Approaches
(Hohpe & Woolf 2004, 5-9)

Information portal gathers information from diverse systems to one location. Information is aggregated and divided into multiple areas. As a result, interaction between different information is offered. (Hohpe & Woolf 2004, 6)

Data replication, in its simplest form, provides an access to the same data by copying data from one place to another. This can be accomplished in different ways. One solution is to import exported files, while another solution is to transport data in the form of messages. (Hohpe & Woolf 2004, 6-7)

Shared business function aims to fulfill a task that is assigned to it. The task can vary from checking the name of the customer to validation of numbers. In this way, a shared business function reduces redundant functionalities and focuses on reusability. (Hohpe & Woolf 2004, 7)

Service-oriented architecture consists of a collection of services with interfaces, communication between services, and service discovery. Each service can be considered as a function that performs a certain task. The task is defined in the request that service consumer sends. To accomplish its task, the service can also call another service. Therefore, services are often reusable, but at the same time loosely coupled. Applications need a centralized list of services to easily find them. This list is also known as service discovery. (Hohpe & Woolf 2004, 8)

In distributed business process, business transaction is spread to different systems and business process management (BPM) component controls the progress of the process execution. Distributed business process is partly overlapping to SOA. Example of this is a distributed business process in the form of a SOA. (Hohpe & Woolf, 8-9)

Most of the previously presented integration approaches considered enterprise applications and services internally. Business-to-business integration extends integration outside the enterprise since business functions provided by business partners or suppliers need to be integrated frequently. This sets requirements for transport protocols, security and standardized data formats. (Hohpe & Woolf 2004, 9)

3.4. Integration Architecture

The difference between integration approach and integration architecture is in abstraction. The integration approach is more of a high level solution and it describes the solution in a process wise while the integration architecture complements the approach with physical components and outlines the technical solution.

There are four integration architectures according to Lam & Shankararaman (2007):

- Batch integration
- Point-to-point integration
- Broker-based integration
- Business process integration

In batch integration the focus is on files which are transferred from one location to another using transport protocols, such as File Transfer Protocol (FTP). The communication is asynchronous and files are not processed real-time. Due to this batch integration is suitable for high-volume back-end processing. Another architecture model, point-to-point integration, utilizes interfaces and the communication takes place directly between them. The downside of this architecture model is high maintenance overhead. In comparison, the broker-based integration consists of an integration hub which acts as a middleware. The communication is established using messages which are routed and transformed in the message broker. This kind of integration architecture supports real time processing but requires separate tools to be implemented. Last architecture model, business process integration, is build up upon broker-based integration. In this architecture the integration follows the workflow which is defined in the business process. The workflow consists of interactions between IT applications and humans. (Lam & Shankararaman 2007, 12-14)

3.5. Communication Channel

The communication channel is the bridge between communicating systems. Messages and files are transferred from the sending endpoint to the receiving endpoint through this channel. If integrations are compared to mail delivery, communication channel is the logistics service. The mail can be delivered with bicycle, car, train, or airplane. This means that there are multiple ways to deliver the mail but the route has to be specified beforehand. In the integration context, this means defining the transport protocol whether it is Hypertext Transfer Protocol Secure (HTTPS) or FTP.

According to Dijkman et al. (2006), a typical communication channel works with following scenarios:

- One-to-one message passing
- Synchronous request/response
- Asynchronous request/response with callback
- Asynchronous request/response with polling
- Multicast message passing with publish/subscribe

One-to-one message passing is the simplest message delivery scenario in which the sender, the party initiating the connection, sends a message to the service provider. In the synchronous request/response scenario the requestor sends the message and waits until a response or exception is received. The asynchronous request/response scenarios differ from this in such a way that the requestor does not wait the response and the response message is delivered afterwards. There are two ways to handle asynchronous communication. Either the service provider sends the response back or the requestor polls the service provider with certain time interval. In both cases the requestor must provide a message id that is used to identify the original message. The last scenario is multicast message passing with publish/subscribe. In this scenario the requestor sends a notification message with certain topic to the service provider. This message is then forwarded to subscribers of this topic. (Dijkman et al. 2006, 332-334)

3.6. Communication Interface

A communication interface, a message endpoint or an adapter, is the point which separates the communication channel from the source or target system. It is responsible for reading and parsing the incoming message into understandable for further use within the ITSM system.

If integrations are compared to mail delivery, the communication interface is the mailbox. The mailbox is the connection point between the logistics service and the mail recipient. The mail is delivered to the mail box from where the recipient picks up the mail. In integration context, the sender application sends the message or file to the receiving endpoint where it is interpreted for further use.

Spackman & Speaker (2005) have categorized interfaces as follows:

- Database endpoints
- File endpoints
- Application endpoints
- Web endpoints

A database endpoint communicates directly with the database. This means that the endpoint knows the database structure, procedures and triggers. Usually database endpoints are connectors that enable insert, query, update, and delete operations on database. Java Database Connectivity (JDBC) and Open Database Connectivity (ODBC) are examples of database connectors. A file endpoint, on the other hand, communicates directly with the file system and converts files into information that is then used by the target system. An application endpoint uses database and file endpoints to communicate with the business layer. These kinds of endpoints are invoked by events based on the underlying process. Differing from the other endpoints, a web endpoint is connectionless, asynchronous and usually stateless. This means that the connection is not opened separately and messages are interpreted independently one by one. Web endpoints can utilize Web services for different transaction calls or web pages to access information. (Spackman & Speaker 2005, 52, 53, 95, 123, 151)

3.7. Data Transformation

Data is the core part of integrations and without data there is no justification to establish integration. On the other hand, data itself is just characters or bits that do not mean anything without a specific context. Therefore, data and information should be observed hierarchically as presented in figure 8.

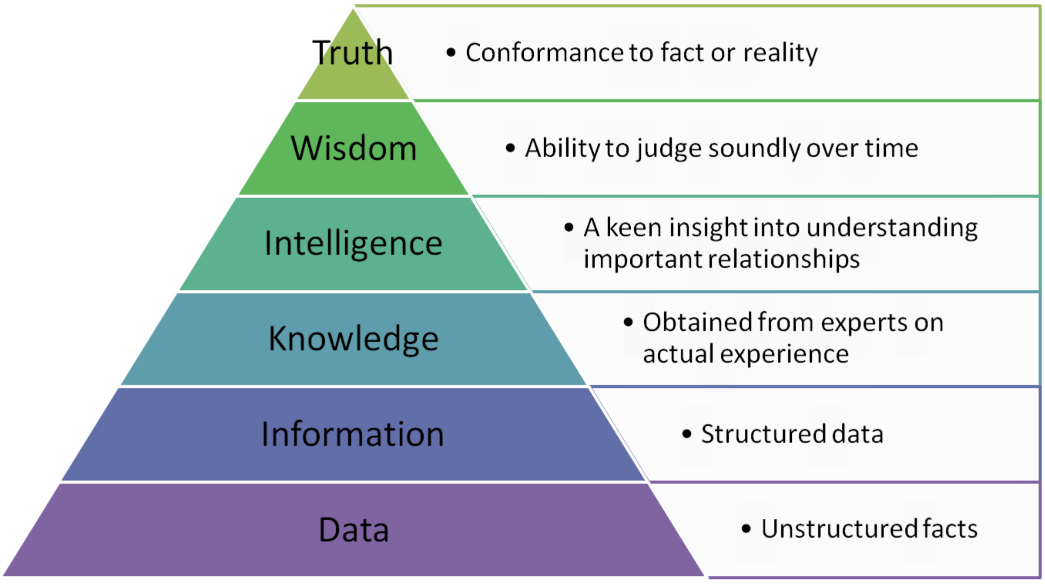
Truth
• Conformance to fact or reality
Wisdom
• Ability to judge soundly over time
Intelligence
• A keen insight into understanding important relationships
Knowledge
• Obtained from experts on actual experience
Information
• Structured data
Data
• Unstructured facts

Figure 8: Information Levels
(Thierauf 2001, 8; Matinlauri 2011, 30)

The lowest level of information is data which contains unstructured facts, such as characters or pulses. This means that data presents information without any context. On the next level of the information pyramid data is structured and it existence is transformed into information. Information gives a context to data by structuring and grouping data. Knowledge, on the next level, is comprised of structured information and it can be considered as information about information. Knowledge combines different contexts of information and compares them with actual experiences of experts. The intelligence level understands the relationships between the facts highlighted by the lower levels and steers the decision making towards the objectives. Wisdom, on the other hand, is achieved through time. It can be gained through experiences, awareness and ability to self-evaluate. Truth is the top level of the information pyramid and it represents the ultimate fact. (Thierauf 2001, 7-11; Tähtinen 2005, 80)

Plain integration refers to data, the lowest level of information. However, when the process flow is linked to integration, data is transformed into information. Further, when people are handling this information, they can add more value from their experiences to this information. This upgrades information into knowledge. Eventually, when reports are run on similar information and knowledge, intelligence level can be reached and correlations and relationships can be found.

Data transformation is the final part of EI. Once the message is received by the endpoint, the data transformation will convert the message into form that is understood by the target system. If source and target systems do not understand information that is exchanged between the systems, they cannot communicate with each other. Therefore, data transformation includes adding, removing, changing, and aggregating data. (Spackman & Speaker 2005, 29-30; Tähtinen 2005, 56)

Data transformation can consist of different layers depending on the transformation need. These layers are from top to down: Data Structures, Data Types, Data Presentation, and Transport. The Data Structures layer transforms entities and associations while the Data Types layer handles field names and values. In turn, the Data Representation layer is used when there is a need to change the data to a different format, for example from the Extensible Markup Language (XML) to the Comma Separated Value (CSV). The very bottom layer, the Transport layer, is responsible for transforming the data content between protocols. (Hohpe & Woolf 2004, 87)

Bertino & Ferrari (2001) have identified three steps for integrating data:

- Data model
- Data schema
- Data instance

A data model is needed to match the information from different data sources to the information in the target system. A data schema, on the other hand, is used to unify and confirm different data structures to one accepted format. This means that the data matches with the target data but it is presented in a different way. An example of this is the currency transformation. Lastly, the data instance ensures that the conflicting information is handled properly. (Bertino & Ferrari 2001, 75)

Data integration contains several sub-areas which are not dealt with this context due to the scope of this thesis. These include data warehousing, data migration, application consolidation, operational and real-time Business Intelligence (BI), master data management, customer data integration and product information management (Sherman 2009, 3).

3.8. Technical Interoperability Recommendations

Linthicum (2004) sees that the digital economy and its ecosystem around us are striving towards automation which makes business more and more dependable on IT. Furthermore, information is expected to be accessible immediately despite the location or device. To respond to requirements set by the business, organizations' IT architecture and applications have to be flexible but at the same support industry guidelines. Therefore, standards and interoperability recommendations should be utilized when designing and implementing integrations.

The table 2 presents interoperability recommendations which are collected from various literature sources. The foremost objective of making this list was to identify open standards and common recommendations without going too deep into technical specifications. As this thesis focuses on ITSM process integrations, the integration approach can be limited to B2Bi. Another limitation is that the list covers only standards related to EI and excludes those that are not. In addition, hardware, software and programming language recommendations are excluded from this list. The list guides with technical considerations but sometimes it is not possible to follow these guidelines due to limitations of an ITSM system.

Table 2: Interoperability Recommendations for B2Bi

Recommendation	Description	Reference
BPM	Management approach for business process orchestration	Josuttis 2007 OASIS 2012 (WSBPEL) OMG 2012 (BPMN) Vernadat 2009
HTTP/HTTPS	Transport protocol	Vernadat 2009 W3C 2012
Message and Service Bus	EI pattern	Josuttis 2007 Vernadat 2009
REST	Architectural style for system integration	Fielding 2000
Service Registry	Metadata repository	OASIS 2012 (UDDI) Vernadat 2009
SOA	Architecture design approach	Josuttis 2007 OASIS 2012 (SOA-RM) Vernadat 2009
SOAP	Network protocol	W3C 2012
Web Services	Software interface	Josuttis 2007 Vernadat 2009 W3C 2012
XML	Data presentation language	Vernadat 2009 W3C 2012

BPM

BPM is a concept which provides methods and techniques for business process design, administration, configuration, enactment, and analysis. Handling of business processes can be accomplished either manually or using software systems which coordinate the orchestration of processes. (Weske 2007, 5-6). According to Vernadat (2009), there are two languages that can be used to model business workflows: the Business Process Modeling Notation (BPMN) and the Business Process Execution Language (BPEL).

HTTP

According to NWG (1999), the Hypertext Transfer Protocol (HTTP) is an application-level protocol which is used to transfer information across the Internet between information systems. The communication takes place using request and response messages. The basic HTTP methods used in integrations are POST and GET. The difference is that the POST method contains embedded payload while the GET method contains only the headers. The secure version of the HTTP is HTTPS which runs over Secure Sockets Layer (SSL) or Transport Layer Security (TLS) (NWG 2000, 2, 4).

Message and Service Bus

Message-Oriented Middleware (MOM) and Enterprise Service Bus (ESB) are message queuing solutions which are used to integrate applications asynchronously. Incoming messages are queued, routed, prioritized and finally delivered to the receiver by the message queue. (Vernadat 2009, 1534)

REST

REpresentational State Transfer (REST) is an architectural style for distributed hypermedia systems firstly presented by Fielding (2000). It is based on different network-based architectural styles and it sets following constraints for the web architecture: client server style, stateless, cacheable, uniform interface, layered system, and code-on-demand possibility. REST provides an alternative for SOAP by delivering data over HTTP with basic methods and simpler integration architecture.

Service Registry

Service registry gathers all service descriptions together and promotes these services. According to Vernadat (2009), service registry describes metadata about services. This can include service name, owner, SLA, and quality information about services. Technically, service registry should describe the basics needed to access the service. UDDI is an example of service registry.

SOA

SOA is an approach for designing software architectures which target to flexibility and loose coupling of services. SOA is comprised of infrastructure, architecture, processes, and governance. (Josuttis 2007, 12, 18, 19)

SOAP

SOAP means stateless message exchange between sender and receiver. A SOAP message is wrapped in an XML envelope which consists of header and body parts. The basic usage scenario is request/response but more complex interaction patterns can be implemented with the application level logic. SOAP can utilize different protocols for transportation but usually the binding is to HTTP. (Ericsson & Lafon 2007)

XML

XML is one of the best known open web standards. It has been defined by the World Wide Web Consortium (W3C) and its text-based format can be used to represent structured information in a simple way (W3C 2010). Despite its simplicity, XML is a powerful tool to present information but the downside is the overhead which increases in long element names and emphasizes in short messages.

Web Services

Web Services enable machine-to-machine communication via web interfaces which can be accessed through the network with standard protocols such as HTTP (W3C 2004). According to Booth et al. (2004), a web service consists of three parts: XML, SOAP, and WSDL. XML provides flexible and extensible data format which is utilized in a standard and composable SOAP framework. WSDL describes the web service interfaces. This includes the bindings to the network protocol and message format as well as the definitions of abstract messages.

4. IT SERVICE MANAGEMENT PROCESS INTEGRATION

Integrations consist of different parts which each have their own purpose and function. The figure 9 presents a high level picture of an ITSM process integration parts. This figure helps to understand a basic structure of messaging integration and familiarizes with vocabulary used in an ITSM process integration. For the sake of simplicity, the integration architecture is selected to be point-to-point approach. Real implementations are complex systems consisting of different integration layers and components.

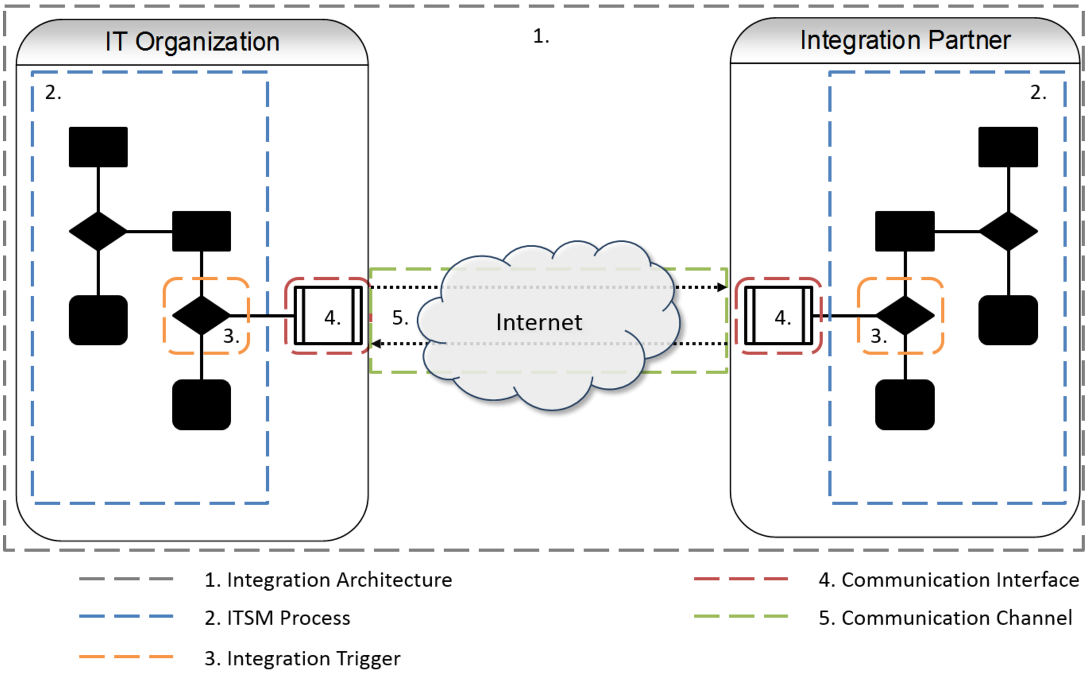

Figure 9: ITSM Process Integration Parts

The goal of this chapter is to describe how ITSM processes are integrated and how EI can be used to support integrations. The chapter combines ITSM theory with practical integration experiences. Firstly, this chapter illustrates what kind of ITSM process integration recommendations ITIL provides. Then the chapter demonstrates best practices for designing ITSM process integrations. The chapter continues discussing about implementations and after this the chapter goes through what actions are needed when the integration is transitioned to production use. Finally, the chapter presents other considerations that are involved in ITSM process integrations.

4.1. ITIL Recommendation

According to OGC (2007b), one of the key principles of managing ITSM architecture is to be business aligned not technology driven. ITIL promotes this by naming five different management areas for ITSM architecture. These areas are presented in figure 10 starting from business requirements and ending to technology.

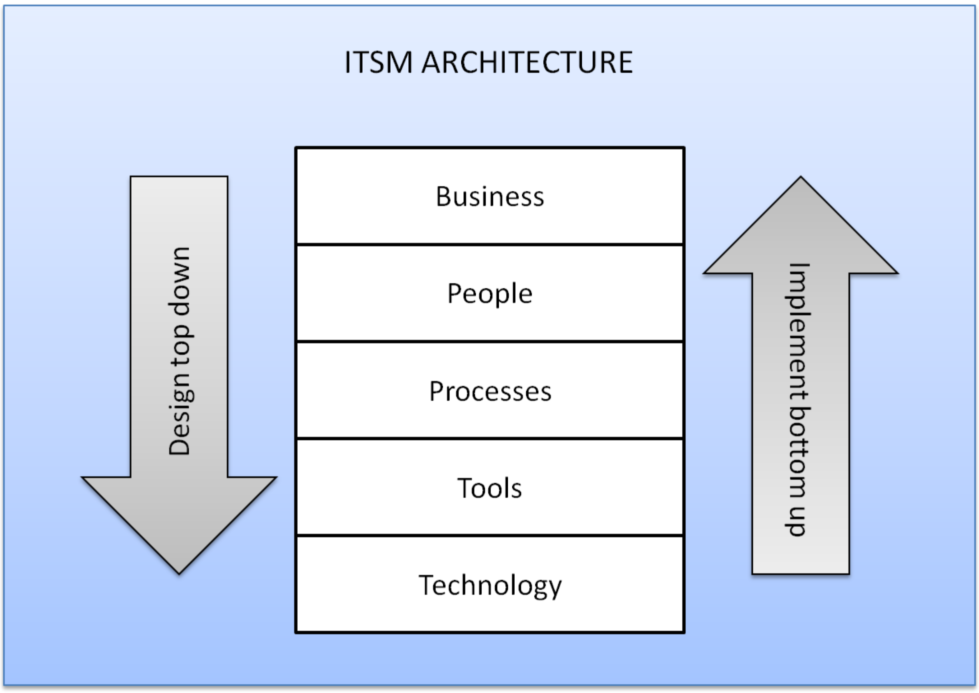

Figure 10: ITIL Technology Management Recommendation
(Modified from: OGC 2007b, 41)

At the top of an ITSM architecture is business layer. This layer is responsible for defining needs, requirements, processes and goals that business sets for the organization. Underneath the business layer is the people layer where the scope and role-based tasks are defined. The layer below is the process layer which, in turn, depicts the procedures used in managing IT services. The next layer, the tools layer, introduces tools used for supporting and managing the IT infrastructure. The very bottom layer is the technology layer which consists of IT products and technologies. The purpose of this layer is to support the layers above and to deliver services both within the organization and beyond its boundaries. The maximum benefit is gained when the ITSM architecture is integrated end-to-end with processes and tools. (OGC 2007b, 41)

One of the best practices that ITIL brings forth is the mindset where design is carried out from the top down and implementation from the bottom up (OGC 2007b, 41). In practice, this means that ITSM management architectures should be designed from business point of view and implemented from the technology point of view. This will ensure that the processes and tools are aligned with business but also integrated efficiently with the technology (OGC 2007b, 41). This same approach can be extended to ITSM process integrations.

4.2. Design

It is important to establish a common language between developers, process people, and business people when designing ITSM process integration. Achieving this objective drives towards business alignment. ITIL provides a glossary that can be used in the process talk but it lacks a pure technical perspective. This gap can be filled with graphical presentations about the integration architecture and visualizing system dataflow with a diagram. Use cases deepen the information in the system dataflow diagram by providing end-to-end scenarios of the ticket lifecycle. Finally, a data mapping document provides a simple, understandable way to map data.

Concluded from the previous discussion, the design of an ITSM process integration can be roughly divided into following phases:

1. Architecture – architecture presentation
2. Process – use cases and system dataflow
3. Data – data mapping

Architecture Presentation

The architecture presentation shows different integration components, communication channels, stakeholders and technical interfaces. In addition, it also illustrates the fundamental integration approach that is used. The architecture presentation gives an overall insight of interconnected systems.

The architecture can be visualized with any drawing tool. In fact, the main point is to present involved components and their relationships. This helps to support the integration discussion and to assign responsibilities between different people. Furthermore, the visualization can be added to the integration design documentation.

Use Cases

Use cases demonstrate scenarios of how an ITSM process can proceed through its phases. They support the system dataflow diagram by providing additional information of the ticket lifecycle. Use cases can be graphical or textural and their main objective is to describe the process flow as comprehensively as possible. It is also important to define the use cases where the process ends up unexpectedly. This way all scenarios are covered and the process does not end up uncontrollably.

System Dataflow

The purpose of the system dataflow is to illustrate data exchange between integrated systems. It hides the technical architecture and presents integrated systems side by side. The diagram can be built up using common process notations, such as BPMN.

The system dataflow suits especially for transactional integrations in which the message content is based on the transaction type. The diagram shows when the transactions are sent and under which conditions. It should especially include status changes since they are usually the main attributes controlling the process. As a summarization, the diagram demonstrates the workflow of the ITSM process from start state to end state.

Data Mapping

Data mapping matches the source data to the target data. This can be accomplished using a data mapping document. Spreadsheets are a powerful tool for this task because different sheets can present different transactions but other solutions are also applicable. In any case, the point is to describe source fields, target fields, data lengths, sample values, and data value mappings.

4.3. Implementation

As OGC (2007b) recommends, the ITSM architecture should be implemented from bottom up. In the ITSM process integration context this means that the implementation is done in the following order.

1. Connectivity
2. Data
3. Process

This order proceeds from application integration to data integration and then to process integration. If the transitioning process is considered, the implementation is done first in development or test environment. Then after successful implementation the solution is placed into production environment.

Connectivity

The connection between ITSM systems is usually implemented first. When the connection is working then it is easier to add more functionality to the integration. In this approach, the interface logic is built up iteratively. In comparison to this approach, the whole process can be implemented before the actual connection. This latter approach requires very good coordination between the two implementation parties. The risks are bigger since no end-to-end testing is possible until the implementation is ready.

The implementation of the connection should be started from the communication interfaces. They are needed for both inbound and outbound communication but sometimes only one interface is enough when the integration is one-directional. The inbound communication refers to the communication from the integration partner system. In comparison, the outbound communication takes place towards the integration partner system. Many ITSM systems provide stub interfaces which can be configured to meet the process requirements. However, it is possible that no interface exists and the interface has to be coded manually from scratch. In this case, it is important to define clearly what inputs are handled and what outputs are produced by the interface.

Once the interfaces are ready, the connection should be configured into both ends of the integration. In practice, this means opening the firewalls, setting up the credentials, and configuring the endpoints. When all of these steps are successfully accomplished the connection can be tested with a test message. The contents of the test message are irrelevant because the main point is just to see that data can be sent and received through the interfaces.

Data

After implementing the connection, the data is implemented into the integration. This part can be carried out using message transactions which each represent a different type of a message.

Message transactions are implemented using the data mapping document which was created in the design phase. The goal is to create an object class for each message transaction. These classes contain attributes that are transaction specific and they act as templates which can be later utilized easily. Furthermore, an abstract class can be created as a parent class to present the message framework. Then the child classes inherit its attributes and the child classes can be customized quickly to meet the requirements.

When incident management is taken as an example, following message transactions are commonly used:

- OPEN
- UPDATE
- REASSIGN
- RESOLVE
- ACKNOWLEDGE

This list refers to actual process steps but in a technical sense. The point of this list is to illustrate the commonly used transactions. The full implementation of the incident management process may require additional transactions depending on the business requirements. For example, attachment sending is also a common requirement in ITSM process integrations.

Process

When the connection is working and the message transactions are implemented, the technical integration and data is combined with the ITSM process. This means that the message transactions are linked to the actual process and to the underlying application layer. All in all, this step transforms the integration into process integration.

The system dataflow diagram is implemented into a working solution in this the process part. The ITSM process is like a reasoning chain; it is controlled by different events, rules and conditions which together direct its execution. Related to this, an integration trigger is a specific condition that links the technical implementation to the process. These triggers start the dataflow process towards the integration partner system. Basically, a trigger calls an integration functionality which dynamically collects all the needed data into a message or a file. After that the integration initiates the connection and transports the data to the integration partner system through the communication channel. An example integration trigger could be a specific state of a ticket or a support group value.

4.4. Transition to Production

Transition to production means the activities that are needed to move a working solution from development or test environment to the production environment. If the solution is implemented in the production environment then the focus of this part is on testing and deployment.

According to OGC (2007e), ITIL defines seven processes for service transition. All of these processes are important but the most relevant in the integration context are: transition planning and support, change management, service validation and testing, and knowledge management. They are presented next slightly modified for the integration use.

Planning

Transition to production requires careful planning because ITSM systems are business sensitive systems. Long outages can be expensive and they impact directly to the user experience. Planning ensures that development efforts are transitioned into production in a controlled manner.

The objectives of planning consist of planning and coordinating resources, ensuring the adaptability, and providing straightforward and clear plans (OGC 2007e, 35). Plans should be documented in a way that different steps can be seen as a roadmap. This helps to visualize the phases involved and gives an understanding about the needed resources.

Change Management

Integration of an ITSM process changes the ITSM system behavior. This is a change that needs to be recorded and handled with the organization’s standard process. This process is known as change management and it is responsible for recording and evaluating changes (OGC 2007e, 43). Change management is also responsible for verifying that all the stakeholders are aware of upcoming changes and that all the implemented changes are controlled. For example, in the integration context it is important that the use of integration is trained.

Testing

Testing is an important part of every implementation. It reduces the risks in the rollout and helps to notice bugs before the production use starts. Testing should forward incrementally and proceed from the component level to the data level and then to the process level. It is important to involve different people in the testing sessions and use the User Acceptance Test (UAT) to verify and accept the solution for the production use.

Basing test cases to use cases makes the core functionality of the ITSM process covered. However, in most times this is not enough for comprehensive testing. Therefore, the test cases should also cover error situations and invalid inputs from the user.

Knowledge Management

The knowledge management is responsible for handling the documentation about the integrations and spreading the knowledge that was gained from the implementation. The basic idea is to ensure that the integration solution is maintainable even if the key person leaves from the project or the supporting organization. This means that the solution needs to be documented so well that the key elements of the core functionality can be understood from this document.

4.5. Other Considerations

Integrating processes is not just making the data to flow from point A to point B. It involves many other things, such as considering possible worst-case scenarios and impact of those to processes. Properly made design helps to prepare these kinds of things but no matter how much time is used in the design phase, there is always a chance that something goes wrong in the production use. Therefore, integrations need to be logged, monitored and occurred errors handled with a predefined process. These activities are part of the support process and should not be forgotten.

Logging

Logging is a simple task of saving information about different activities in the ITSM system. Logging is extremely useful when something needs to be clarified and without proper logging it is not possible, or at least difficult, to find out the root cause of the problem. On the other hand, logging everything is not a good practice either. This will lead to information overflow increasing data masses. Therefore, a balance in the right amount of logging should be found and a good practice is to have logging levels. For example, debug logging can be used in the beginning and after everything is working, the logging level can be decreased.

It is hard to make a clear distinction of what and when should be logged. From incident management integration perspective logging should be enabled for sending and receiving messages. The logged information should contain, at the fewest, transaction, identification, status, and dialog information. The debug logging, on the other hand, should log entire messages that makes a complete data level comparison possible. This helps to pinpoint the problem source faster, and helps in the cases where the problem source is unknown.

Monitoring

Monitoring is the activity of observing the process and dataflow in the ITSM system. It ensures that everything proceeds like expected and unexpected events are caught. At the same time it supports error handling by alerting about inconsistencies. Every component should be monitored in the integration chain. This ensures that problems are noticed, located and fixed rapidly. Monitoring can be implemented with listeners, conditions, and rules.

Error Handling

Errors are inevitable and for this reason they should be prepared to. In ITSM process integrations the focus of error handling should be on end-to-end and component levels. This means that process level errors should be handled in the process itself and individual errors by the components that are currently processing data.

Wrong kind of data, missing data, connection problems, and outages are the common errors faced in the integrations. Nevertheless, there are different ways to prepare for these. Incorrect data may be due to incomplete data mapping. Thus, a maintainable field and data mapping helps implementing rapid mapping changes. Otherwise, data related errors can be solved with error messages and retransmissions. The connection problems and outages can be handled with good monitoring, message queuing and acknowledgements. The key point here is to store the messages for traceability and recovery. In case of an outage the failed messages can be then resend and no messages are lost. Therefore, the ITSM system should keep up with the information of which messages are transferred correctly and which not.

Security

Security ensures that confidential data is handled properly and only authorized people can see the data. Like the error handling, security can be implemented on different levels depending on the need.

The component level security is implemented within the ITSM system with secure protocols and restricting the access to external APIs. The data level security, on the other hand, can be created with message encryption or restricting access to data from certain users. The process level security is created with well-defined processes which take care of exception handling. For example, users can be restricted to do unwanted updates.

5. FRAMEWORK FOR SERVICE MANAGEMENT INTEGRATION

ITSM process integrations follow a certain process which can be modelled and supported with the integration framework. The framework divides service management integration into architecture, process, data, and technology sections. Each section has its own goals which can be achieved with the framework tools. Besides this, the integration framework provides a deployment model which steers the integration project from design to transitioning to production.

The framework is intended for designing ITSM process integrations but it also supports implementation and testing of integrations. As a limitation, the framework is not an all-inclusive technical guide but it is more of a generic integration framework. In addition, project management considerations such as schedule, budget and roles are excluded from the structure. They should be handled separately using project management best practices.

This chapter begins with a description of integration framework development. Then the chapter continues by presenting the framework structure. After this, the framework tools and their usage are presented. The last part of this chapter describes the deployment of the integration framework.

5.1. Framework Development

The development of the integration framework was started by setting initial requirements which acted as guidelines for finding different theories in literature, especially about ITSM and EI. The findings from literature review were combined with practical experiences of the researcher and as a result of this combination, an integration framework was created. The whole development process of the integration framework is presented in the figure 11.

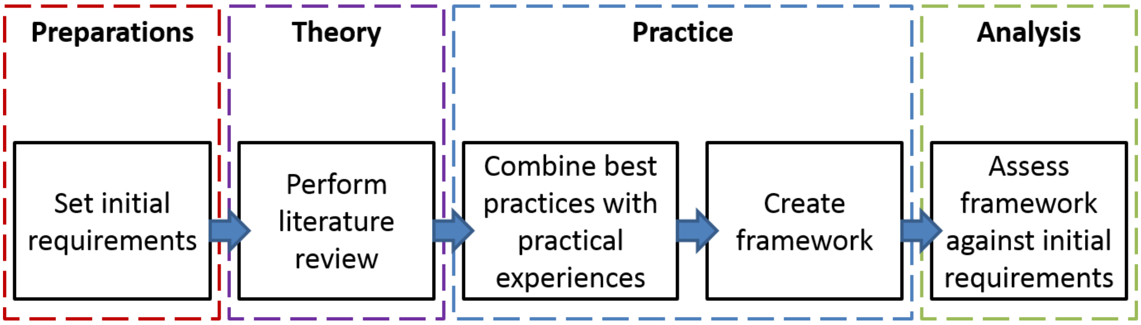
Preparations
Theory
Practice
Analysis
Set initial requirements
Perform literature review
Combine best practices with practical experiences
Create framework
Assess framework against initial requirements

Figure 11: Integration Framework Development Process

Problem Definition and Objectives

The problem to which the integration framework answers is a combination of the two research questions presented in the first chapter. The first research question searches best practices for integration between IT organization and integration partner in a process wise. The second research question explores the characteristics of efficient and maintainable integration interfaces with interoperability in mind. Therefore, the foremost objective of the integration framework is to present a general model for end-to-end integrations between an IT organization and an integration partner systems in process and technology wise.

Requirements

The priority one requirement was genericity which was presented in the thesis assignment. This requirement was set to distinct the framework from tool specific instructions. Business and technology awareness, ease of use, and tool neutrality requirements were conducted from the need to support day-to-day integration work in integration projects at Sofigate. Layered structure, modularity, and reusability requirements were conducted from Erl’s (2008b) SOA design principles which are commonly known best practices for technical service design. The table 3 summarizes all these requirements and gives a more detailed description of each requirement.

Table 3: Integration Framework Development Requirements

Requirement	Description
Business and technology awareness	The integration framework should take both business and technology into consideration.
Ease of use	The integration framework should be understandable among different user groups, such as within developers, architects, business users, and executives.
Genericity	The integration framework should be adaptable to different ITSM integrations.
Layered structure	The integration framework should prefer abstraction in order to hide unnecessary details.
Modularity	The integration framework should consist of different parts or modules that could be combined in different ways.
Reusability	The integration framework should be reusable in order to be adaptable into different integration situations.
Tool neutrality	The integration framework should support different ITSM tools and integration platforms.

5.2. Framework Structure

The integration framework structure is a four-division between architecture, process, data, and technology. This core structure of the framework was conducted from ITIL technology management recommendation (OGC 2007b, 41), The Open Group Architecture Framework (TOGAF) domains (Open Group 2009, 54, 61), and the EA recommendation presented by the ICT Standard (Huovinen et al. 2012, 69). Additionally, practical experiences from real ITSM process integration designs have supported this structure.

The integration framework structure is presented in the figure 12. The figure presents a best practice approach for ITSM process integration design. The same structure can be used for implementation and testing but in an opposite order and with minor modifications. The blue circle in the figure indicates the core framework and the grey rectangles are extended parts which describe the design objectives of each area.

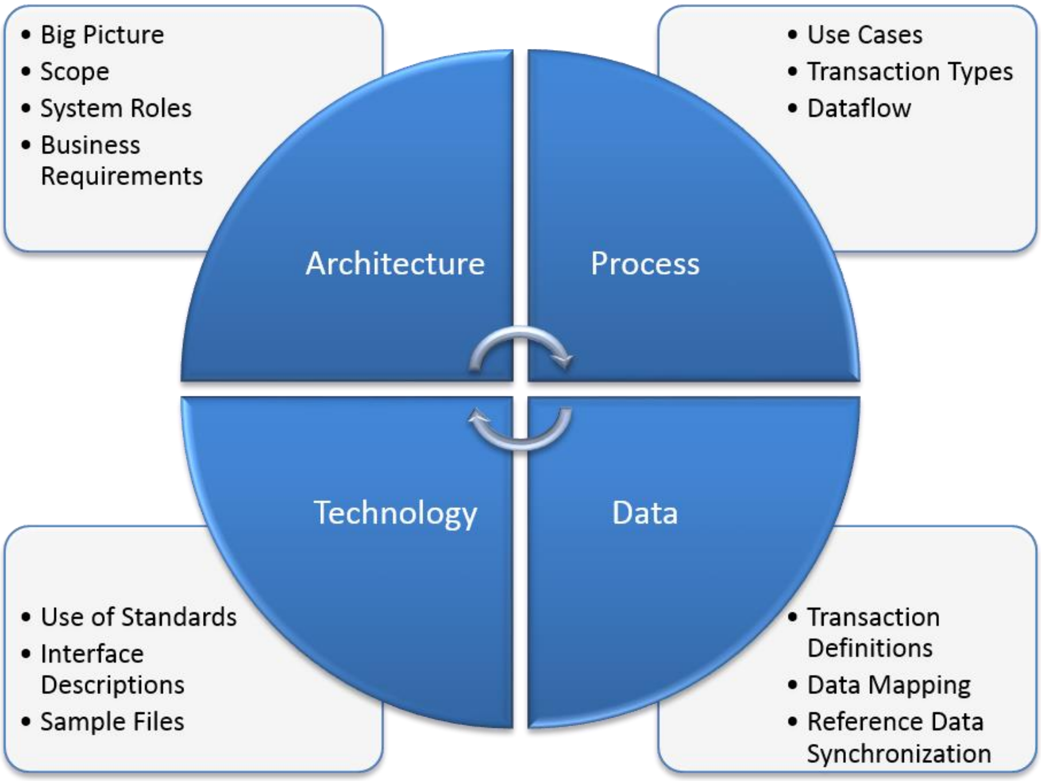

Figure 12: Integration Framework Structure
(Conducted from: Bertino & Ferrari 2001, 75; Huovinen et al. 2012, 69; Kruchten 2004, 12; OGC 2007b, 41; Open Group 2009, 54, 61)

The integration framework starts from the upper left corner where architecture initiates the integration design. Architecture creates an integration strategy which is a cornerstone for design. It clarifies integrated systems, system roles, integration interfaces and business requirements (Huovinen et al. 2012, 69). Architecture is also responsible for agreeing about integration scope, in other words, what is included and excluded in the integration. It supports process design and aligns business requirements to other sections.

Kruchten (2004) suggests that software systems should be modelled from different perspectives consisting of state, component, deployment, use-case, scenario and class diagrams. Therefore, the process section of the framework starts with defining integration use cases. The use cases help to understand functional requirements of the integration and provide details about the integration process. After use cases are defined, transaction types need to be identified. In this context, they are message types which describe operations in a process wise. Further, the dataflow diagram, conducted from state and scenario diagrams, visualizes use cases and transaction types in a process diagram. This diagram links process design to data design and documents instructions for implementing the process logic.

The data section targets to describe how data is received and sent in the integration. Therefore, this section starts with complementing the transactions, both inbound and outbound, which were identified in the process section. As a clarification, inbound transactions are received from external systems while outbound transactions are transferred to the external system. Bertino & Ferrari (2001) presented data model, data schema and data instance to describe data integration. These enablers of data integration can be summarized to data mapping. Simply, this means matching source data to target data but it can contain data altering or data enrichment steps. Based on previous experiences, ITSM process integrations contain relational data, such as business services, categories, or users, which is scattered over different database tables. This data is then referenced from the original ticket through a key field. Technically, the integration needs to exchange pre-approved values between these reference fields. There are two alternatives to handle reference data: one-to-one mapping or data import. Maintaining one-to-one mapping requires manual work and thus an automated or semi-automated process for reference data synchronization should be preferred. This can mean a separate batch integration or a procedure where data is first exported and then imported manually. One of the systems needs to be the master or a third system needs to provide the master data since the main objective is to keep the data synchronized in both sides on a daily basis. These observations and continuous mapping problems with the reference data were the reason why the reference data synchronization concept was placed in the framework.

Technology provides capabilities for ITSM process integration making it as the foundation for the framework. Technology supports architecture design with standardized technologies and protocols (Huovinen et al. 2012, 69). Furthermore, the technology section provides documentation about integration interfaces and connectivity. Even though the documentation should be started at the architecture section, the handover takes place after this section initiating the implementation. Based on past experience, interface specifications are complex and hard to understand. To address this issue, the integration framework recommends creating a sample file of each transaction type with real data. This will help an integration partner to start internal testing by simulating the sending party with the provided data prior establishing end-to-end connectivity.

Implementation Model

If the core structure of the integration framework is observed in a reversed order, an implementation approach can be identified: technology, data, process, and architecture. The approach follows OGC's (2007b) philosophy "design top down and implement bottom up". Even though this is a very rough division of steps, it illustrates how implementation should proceed incrementally from technology and connectivity towards architecture and business. In other words, each step presents a layer which is responsible for specific functionalities. Linthicum (2000) has presented a similar approach for observing data in EAI context consisting of data, logic and user interface layers. This structure was combined with the integration framework structure. As a result, an implementation model for ITSM integration was created. The last layer from the original structure, architecture, was changed to the user layer due to better suitability to the context. The implementation model is presented in the figure 13 where different layers, their functionalities, and their relationships are visualized. The relationships are shown between the layers and the functionalities within the layers.

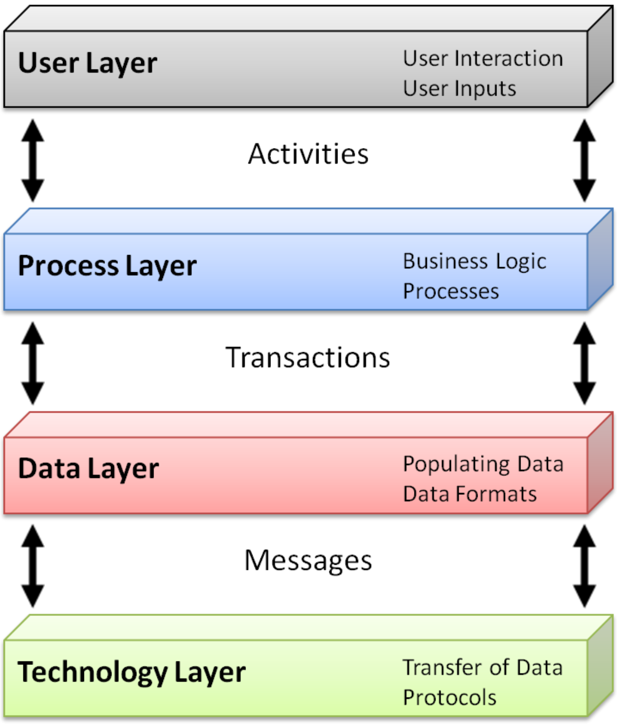

Figure 13: Implementation Model for ITSM Integration
(Conducted from: Linthicum 2000, 24; Open Group 2009, 54, 61)

Generally speaking, business people view things differently than IT people. This puts pressure on communication between different project members. Implementing ITSM integration through layers enables seamless communication among developers, process owners, and project managers as it simplifies the solution and drives the solution towards SOA approach by separating and hiding implementation components between the layers. This, in turn, helps to describe the solution structure to the whole project team.

The user layer handles end user’s actions and it operates directly on the user interface. The process layer focuses on business processes that comprise the business logic. Further, the data layer is responsible for populating integration messages in a correct data format. Lastly, the technology layer handles message transfer methods and protocols. When relationships between layers are examined more accurately, it can be seen that user activities trigger business logic. This leads to execution of business processes and generation of integration transactions. The data layer populates these transactions and forwards them as messages to the technology layer, which transfers them to the target destination.

The implementation model for ITSM integration should be used as a skeleton for building up the solution. Thus, the final solution is compiled of different components which provide the required overall functionality for each layer. The implementation proceeds in line with the testing making the project approach agile. In practice, this means that components are tested with unit tests, data methods with functional tests, a process with end-to-end tests, and overall solution with user acceptance tests. Therefore, the implementation preferably starts from the technology layer and ends to the user layer.

Testing Model

Like the implementation model for ITSM integration, the testing model follows the integration framework in a reversed order: technology, data, process, and architecture. This approach is not directly applicable for testing but it, in turn, provides a context level structure for testing recommending testing to be done with bottom-up orientation.

There are four core testing phases: unit testing, integration testing, system testing, and acceptance testing (Burnstein 2003, 134). These phases acted as a baseline for creating the testing model. When this baseline was evaluated against the contextual structure of the integration framework, it was noticed that some phases of the original baseline did not fill all the testing needs for ITSM integration. Therefore, functional testing replaced integration testing and end-to-end testing replaced system testing. Basically, the replaced ones had similar objectives with the ones that replaced them. However, the new ones described integration testing better in the ITSM context and they were conducted from the integration framework structure and experiences from ITSM integration projects.

According to Rick & Stefan (2002), modern testing approach proceeds in conjunction with the implementation. Therefore, testing can be seen as an iterative process where components and process are tested step by step instead of everything together. This has been the idea behind the testing model for ITSM integration presented in the figure 14.

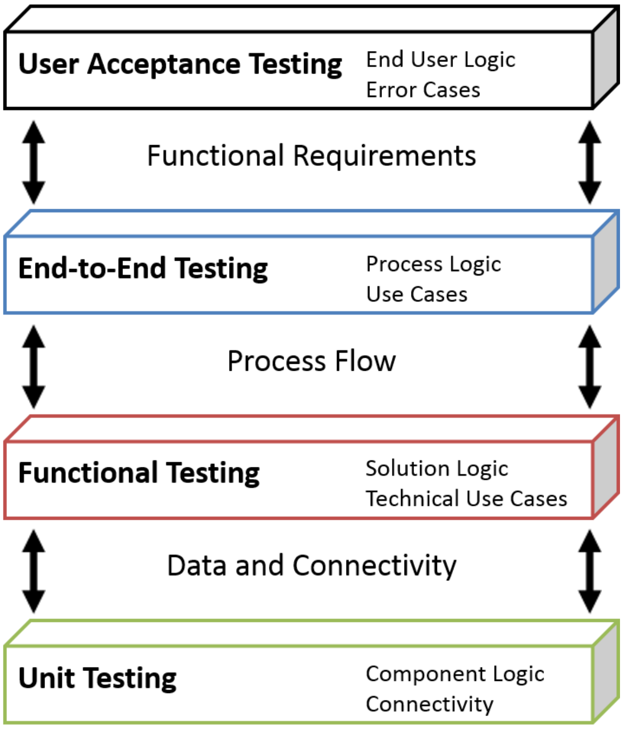

Figure 14: Testing Model for ITSM Integration

(Conducted from: Burnstein 2003, 134, 164, Rick & Stefan 2002, 11)

Testing begins in the early phases of the implementation with unit testing. The unit tests focus on testing different components, interfaces and connectivity. Once connectivity is tested and established, solution logic can be tested with technical use cases. The purpose of this testing step is to achieve technical readiness for process testing. The end-to-end process testing ensures that the process is correctly synchronized with the integration and the integration is aligned with the ITSM process. This testing phase requires input from process people and cannot be completed only between technical people. The final testing phase is the user acceptance testing where end users should test the integration from their perspective. This phase ensures that the integration meets functional requirements and different user groups can use the integration from their perspective. Additionally, different error handling scenarios should be tested in this phase. For example, an end user assigns ticket to another integration partner, inputs wrong information to a certain field, or handles the ticket against the process. The idea behind this is to understand how the system works in these unexpected situations.

5.3. Framework Tools

The integration framework provides tools that provide a best practice approach to achieve design objectives. These tools are presented in the table 4 where each tool relates to a specific section or sections in the framework circle.

Table 4: Integration Framework Tools

Tool	Framework Association	Reference
ITSM integration requirements pre-study template	Architecture	Hohpe & Woolf 2004, 5-9 Lam & Shankararaman 2007, 12-14 Dijkman et al. 2006, 332-334 Spackman & Speaker 2005, 52, 53, 95, 123, 151 Vernadat 2009, 1533-1535
Use case template	Process	Burnstein 2003, 179 Holub 2000
Dataflow diagram template	Process	Combined from state diagram and scenario diagram
Transaction definition template	Data, Technology	Conducted from practical needs
Integration framework presentation	All	

ITSM Integration Requirements Pre-study Template

The ITSM integration requirements pre-study template gathers information to make design considerations. It is related to the architecture section of the framework and works as a starting point for ITSM integration discussion with the integration partner. The template is structured to gather information about integration approach, integration architecture, communication channel, and communication interface (Hohpe & Woolf 2004, 5, 99, 463; Lam & Shankararaman 2007, 12; Spackman & Speaker 2005, 52; Tähtinen 2005, 53).

The Appendix A presents ITSM integration requirements pre-study template in use. The answers in the document are highlighted in yellow and they represent typical ITSM integration case. Based on these answers, the integration interface would be SOAP web service with asynchronous communication model. The communication would be bi-directional in limited sense meaning that Organization B cannot initiate communication. As the integration partner has standard interface, the IT organization needs to implement the web service using integration partner's static WSDL or alternatively middleware can be used in between.

Use Case Template

Use cases are commonly used approach to describe functional requirements of the system but they can be also used to describe system behavior (Burnstein 2003, 179). Since the use case method describes the process flow from different perspectives, it suits well for describing the ITSM integration process.

According to Holub (2000), a formal use case consists of name, description, desired outcome, user goals, participants/roles, dependencies, preconditions, scenarios, workflow, post conditions, business rules, requirements and implementation notes. These are included in the template with certain limitations making the template applicable for ITSM integration development but also for other system development.

A sample use case for incident management is described in the Appendix B. This use case is modified from real-life situation where the integration partner is providing support services for the IT organization. The use case describes exemplar where Organization A raises an incident and Organization B resolves it. In this case, Organization A has its own service desk which provides first and second level support for the own organization. In turn, Organization B provides third level support for the Organization A meaning that when Organization A resolvers do not have capabilities to resolve an incident they escalate it to Organization B. This use case is text-based and it describes the process from end user's perspective.

The whole integration process consists of the following use cases:

UC1. Incident is raised by Organization A

UC2. Incident requires more information from Organization A to be resolved

UC3. Incident requires more work from Organization B to be accepted

UC4. Incident is rejected by Organization B resolver

UC5. Incident is resolved by Organization A after it has been exchanged

Dataflow Diagram Template

The dataflow diagram template presents a process diagram which demonstrates integrated systems and dataflow between them. It gives a quick overview of the integration process and supports use cases by describing the integration process from system perspective. This relates the dataflow diagram both to the process and data section of the integration framework. Modelling a process with the dataflow diagram requires knowledge of process notation languages and input from process people.

The dataflow diagram template is constructed as Microsoft Visio file and the template is prefilled with some process notations to ease the process visualization work. The top row in the diagram defines the ITSM process name while the row below gives a short description of the main flow of events. On the left hand side, the diagram is split into integration partner and IT organization sections. These sections separate the responsibility of actions and they both consist of function and system parts. The function part refers to handlers, in other words to the human aspect, and the system part to the underlying ITSM system. The line between integration partner and IT organization sections is important because arrows crossing this line act as integration transactions. The last swim lane is the subprocess which describes a flow of events that is not part of the main process flow.

The process which was already defined by the use cases is now presented in a form of system dataflow in the Appendix C. This diagram is exemplar of incident management process from the system perspective. The diagram visualizes the use case 1, illustrates the used transactions, and shows associations to other use cases. The process is simple and does not allow initiation of incidents by Organization B. The dashed arrows demonstrate automatic message flow meaning that no user action is not needed.

The use case 1 consists of the following transactions:

- OPEN by Organization A
- ACK by Organization B
- RESOLVE by Organization B
- CLOSE by Organization A

In order to complete the whole process, the following transactions are required:

- UPDATE by Organization A (UC2)
- REASSIGN by Organization A (UC4)
- REASSIGN by Organization B (UC3)
- RESOLVE by Organization A (UC5)

Transaction Definition Template

The transaction definition template is designed for identifying integration needs at the data level. The template is used for describing integrated data and message types.

The default template consists of the following sheets:

- Version history
- Transaction overview
- OPEN transaction for both IT organization and Integration partner
- UPDATE transaction for both IT organization and Integration partner
- REASSIGN transaction for both IT organization and Integration partner
- RESOLVE transaction for both IT organization and Integration partner
- ACK transaction for both IT organization and Integration partner
- Value mapping

The transaction definition template is related to the data section of the framework but it also supports the process section by providing contents for the transactions. The header of the main sheet tells the transaction name and the initiator of the transaction. In addition to field mapping, the template provides direct value mapping capabilities. This means matching field values one-to-one.

The template is divided into three parts which illustrate a source system (IT organization system), a target interface (XML), and a target system (Integration partner system). Even though the template expects data to be in XML format, the template can be modified to be used with other file formats as well.

The Appendix D shows an exemplar of how the tool is used. The exemplar presents OPEN transaction initiated by Organization A. This transaction has been modified from the real integration mapping and, thus, represent actual fields that are usually transferred in the incident integration.

Integration Framework Presentation

The integration framework presentation gives an overview of the framework outcome. It summarizes the framework findings, presents the implementation and testing models, and goes through the deployment model. It is a quick reference guide for ITSM integrations and to the integration framework. The presentation goes through goals, principle solution, implementation steps, best practices, benefits and practical examples.

5.4. Framework Deployment

The integration framework is deployed using ITIL technology management recommendation where design is done top down and implementation bottom up (OGC 2007b, 41). The deployment order is conducted from the integration framework architecture, the implementation model and the testing model. The figure 15 describes the deployment process for the integration framework.

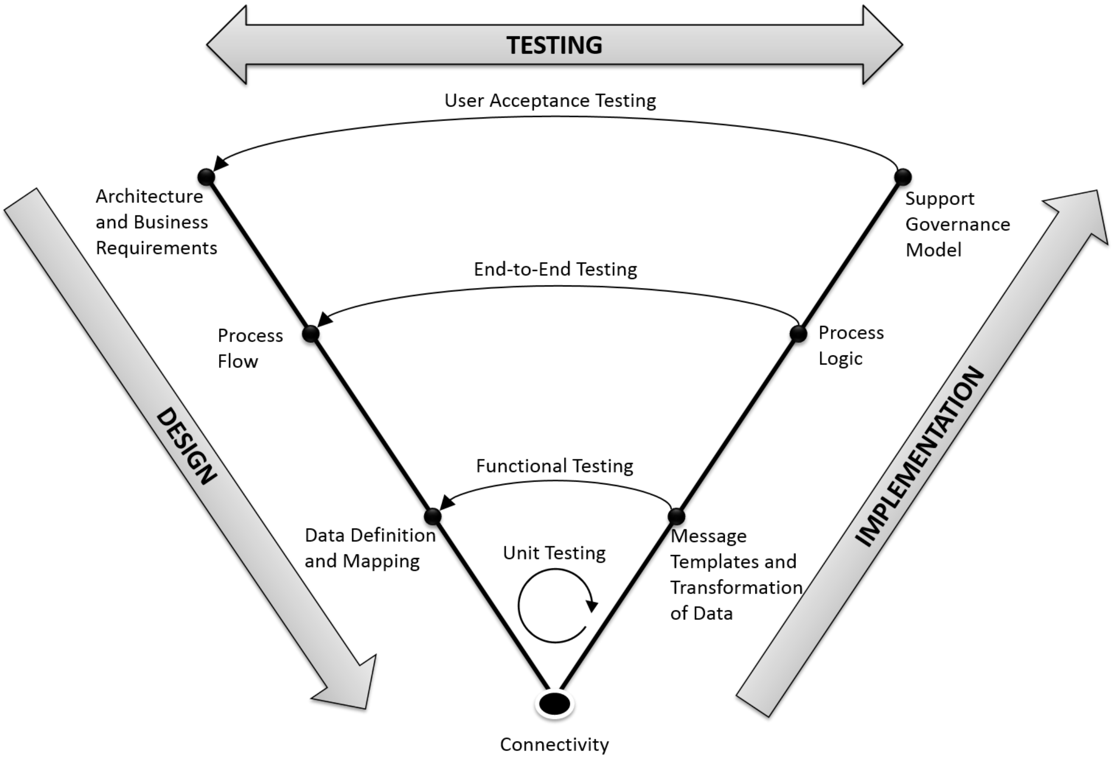

Figure 15: Deployment Model of the Integration Framework

The figure is divided into three main phases: design, implementation and testing. Design tasks can be carried out with the integration framework tools and recommendations. Implementation and testing phases do not have any related tools at this point. However, the framework provides a suggested order to complete these phases in a controlled manner.

The design phase starts outlining the integration architecture and the business need. This means clarifying integration components and technical interfaces. Additionally, the architecture definition also aligns business requirements to the design phase by presenting functional requirements for the integration. Thus, this is a good starting point for the integration project. The integration framework provides a pre-study template for collecting necessary information to sketch the integration architecture. In addition, the framework provides technology recommendations that can be used as a basis for making architecture and technology decisions. The next task towards completing the design is to describe the integration process flow with the use case template and the dataflow diagram template. After those are done, data mapping is carried out with the transaction definition template. The design phase ends with collecting connection endpoint addresses and credentials.

Sometimes it is justified to make this last task as early as possible and agree about connectivity, especially when firewall openings tend to take time. This minimizes the idle time between different tasks in the implementation phase.

The implementation and testing phases proceed concurrently. The implementation phase starts with configuring the connectivity and firewall openings. This is followed by the connectivity testing which ensures that connections are open between integrated systems. The implementation continues creating outbound transactions and inbound data transformations based on the transaction definition template. These implementation steps are followed by the iterative unit testing. This means that each implementation component or entity is tested individually ensuring that implementation units accept certain inputs and produce certain outputs. When the unit tests are done, the functional testing takes place. It can be considered as technical end-to-end testing as it requires input from the integration partner system. After implementing and testing integration in a technical sense, the integration should be completed with the ITSM process relations utilizing the defined use cases and the dataflow diagram. Once the solution is ready, the process is tested with process end-to-end tests using real scenarios from use cases. The testing ends with the user acceptance testing which ensures that the process and its components work like expected. In addition to this it ensures that error handling works like the support governance model states.

The suggested order for implementation and testing can be overlapping can contain additional tasks depending on the complexity of the solution. This particular order was chosen to support the reporting of project progression and to ease the management of integration implementation.

6. ANALYSIS OF INTEGRATION FRAMEWORK

The integration framework presented a generic approach for ITSM integrations. The framework was composed of the framework visualization, framework tools, and three models, which were implementation, testing and deployment. To obtain more information about the maturity of the framework, the framework is analyzed in this chapter.

The chapter starts with evaluating how well the outcome of the integration framework meets the criteria set at the beginning. After this the chapter discusses about benefits that the integration framework provides and, finally, the last part of the chapter outlines development possibilities.

6.1. Comparison with Initial Requirements

In the very beginning there were seven generic requirements that were guiding the framework development work. These requirements are used as a basis for the analysis by comparing the framework to each requirement. If a requirement is not completely met then reasons for this are discussed and change proposals are addressed.

Business and Technology Aware

Business and technology are domains that should cooperate to achieve common goals. Still, they often operate on silos making a gap between them. The integration framework fulfills this gap by taking a layered structure which takes both aspects into consideration. The structure assumes that the business layer, and more specifically the architecture layer, provides the need and the technology layer answers to this need by providing capabilities. The framework presents also a process and a data layer which operate in between architecture and technology layers providing more detailed view to the integration and narrowing the gap further.

Ease of Use

The integration framework has been designed for different users taking into account developers, project managers, process owners, and service managers. The framework can also be used as an introduction material for anyone who has interest in integrations. Due to variety of users, the framework has to provide simple core structure so that anyone without specific competence can use it.

The key point that makes the framework easy to use is the straightforward deployment model. It divides the integration project into clear phases and tasks. In addition, the framework uses figures and charts to illustrate complex things, such as processes and dataflow. In any case, ease of use cannot be evaluated subjectively until the framework has been widely used among different users and in different cases.

Genericity

Each integration solution is different, at least, when certain level of particularity is reached. There is no justification to make an integration framework which contains only specific implementation instructions if the priority one requirement is genericity. These implementation instructions have their place but they should rather support a generic framework than work as themselves.

The integration framework can be reused for different ITSM process integrations. This makes the framework generic. An enabler for this can be found from the abstract and simple structure of the framework which provides general objectives and tools to design integrations. In addition, the provided best practices are applicable for any ITSM process, ITSM tool or implementation technology.

Layered

The integration framework consists of a layered structure which supports information abstraction. The framework layers are architecture, process, data, and technology which emerge in the design phase. From the applicable parts this structure is also valid in the implementation and testing phases. The architecture is replaced with the user layer in the implementation and testing phases. As the user layer associates closely with user actions and expectations, it is used for handling user inputs in the implementation phase and doing UAT in the testing phase. Detailed description of design, implementation and testing phases is presented in the framework deployment model.

Modular

A modular structure enables combining different parts together without breaking the overall structure. This requirement was originally intended for component libraries which were left off from the framework outcome due to the tool-centricity. The integration framework can be still seen as modular because it separates the framework structure, the deployment model, the implementation model, the testing model, and the tools. Each of these can be used independently without others or alternatively they can be combined with each other in different orders.

The objective of the modular structure requirement was slightly unclear, especially when the target was a framework. Thus, it was hard to evaluate the outcome to the requirement and assess the modularity level. Nevertheless, the framework increases its modularity level over time when there are more results and sample material to be used creating mass customized processes. The idea behind this is creating complete building blocks for ITSM processes which can be then utilized in diverse compositions.

Reusable

Reusing a code snippet, a use case, a template, or even an architecture is highly advisable as it saves time from reimplementation or from redesign. To be able to reuse, unchanged parts needs to be identified from the code, process or architecture.

The framework has been designed to unify integration design with the common steps which can be repeated. Since IT organizations are mostly using same ITSM processes, the framework can be easily reused when integrating these processes. Furthermore, the tools provided by the framework are already reused several times in Sofigate Oy.

Tool Neutrality

Since the framework is purposed to be used openly in any organization, the tool neutrality was an absolute requirement. Due to this, the framework or its tools do not contain any references to ITSM tool specific information or present ITSM tool dependent principles. In addition, the framework is generic by nature which supports the tool neutrality.

Even though the framework is vendor and ITSM tool neutral, it should be complemented with specific implementation instructions to maximize the impact and benefits of the use. These instructions should be stored in a same location with the framework, such as in IT organization's knowledge base.

6.2. Benefits

The integration framework brings benefits which can be achieved through the comprehensive use of the framework. Even though there are several benefits to be highlighted, these benefits can be summarized into main ones which illustrate how the framework helps in the daily ITSM integration work.

Following main benefits can be achieved through the use of the integration framework:

- Common language to use
- Easy and rapid to deploy
- Unified working methods
- Business alignment for integration
- Straightforward process to follow
- Readymade tools for integration design
- Standard outcome documents
- Utilization of industry standards

IT organizations can advance their ITSM integration knowledge with the integration framework but also use it as a basis for discussion between integration partners. Common language is the key for successful integration projects as it reduces misunderstandings and makes work more efficient. The framework helps different user groups perceiving integration process and provides an easy to understand terminology which extends ITIL. Additionally, the simple deployment model enables rapid adaptation of the framework. This is because the framework explains ITSM integrations in a practical way and avoids focusing on mysterious buzzwords.

The impact of the integration framework shows in the everyday work. The framework unifies working methods and helps ITSM integration projects to start from the right angle. This, in turn, means that the design starts from the architecture definition making business requirements comprehensively aligned to the integration. To give an example of practical usage, the integration framework has been used for planning integration project tasks and integration workshop agendas within Sofigate Oy.

The integration framework deployment model together with the design objectives provide straightforward steps that help project managers to understand integration project tasks. When the projects tasks are clear, it is easier to estimate workloads and budgets but also to allocate resources. The deployment process is supported by readymade tools which help to complete ITSM integration design comprehensively. In addition, these tools produce standardized documents which can be used as implementation specification. These include a use cases description, a dataflow diagram, and a mapping document.

The technical interoperability recommendations of the integration framework promote the use of industry standards ensuring technical compatibility in the future. However, this list of recommendations should be reviewed and updated periodically to meet the criteria for modern integration.

6.3. Development Areas

The integration framework has one ultimate long-term objective of transforming the framework into the service management integration framework where business is guiding process and system integration. This transform can be achieved in small steps with service management principles. This means identifying and implementing short-term development areas one by one.

Following short-term future development areas can be identified:

- Build component libraries
- Create mass customized processes
- Complement with practical instructions
- Develop new tools
- Extend the scope from ticketing integrations
- Implement error handling and security aspects
- Implement service level monitoring

Comparing the framework against the initial requirements did not reveal any surprises since nearly all of the requirements were fulfilled. One exception was modularity, which did not achieve the wanted level. To address this misalignment, the integration framework should be complemented with process building blocks which enable mass customized processes. These building blocks consist of readymade use cases and related component libraries of code. The mass customized processes and the component libraries would then reinforce the implementation phase. Originally, the initial sketch of the integration framework contained the component libraries but they were delimited from the core framework since they were tool-dependent.

The comparison showed that the framework is ITSM tool neutral but it lacked practical guidelines. Here lies a contradiction since more specific instructions make the integration framework more tool-dependent while the current form of the framework is too generic. Additionally, the integration framework provides a baseline for integrations but the framework focuses mainly on design phase making implementation and testing less covered. This makes the framework more of a design tool than overall framework. A solution for this is to develop new tools and add external practical instructions to guide through the integration. For example, an implementation guide, a reference data synchronization template, and a test case template are missing from the framework. The implementation guide would provide detailed technical instructions for implementing different integration approaches. The reference data synchronization template would support achieving overall ITSM integration design objectives by clarifying data model differences between integrated ITSM systems. The test case template would give practicality for the testing phase and reinforce the phase with a new tool. However, the implementation guide was excluded from the framework to keep the framework tool neutral. The two latter tools were excluded since they were not directly related to the design phase.

The scope of the integration framework was ticket integrations between IT organizations and external integration partners. Even though this scope covers the most common ITSM integrations within IT organizations, there is a need to extend the scope broader and support diverse ITSM integrations, such as batch integration. Since all integration designs follow the same pattern as presented in the framework architecture, the core part of the integration framework is usable for any integration design already. In order to do this, the design objectives need to be updated to support other integrations as well. In practice, this means that there would be alternative deployment models for different integrations which would be then supported by new tools. For example, event-based integrations and batch integrations could have different integration approach which is determined in the architecture definition.

According to van Bon et al. (2008), availability, capacity, performance, security, confidentiality, scalability, adjustability, and portability are attributes that measure service quality. These attributes also reflect to the quality of integrations and further to the structure of the integration framework. It is not reasonable to compare the integration framework outcome against them as they require operational level metrics for measurement. In turn, the integration framework should focus on improving these aspects and providing best practices that lead measuring them. As a conclusion, error handling and security features should be added into the framework. This will indirectly enhance all of the attributes, especially availability, security and confidentiality. In addition, monitoring of service levels should be taken part of the framework to enable the measurement of quality in ITSM integrations. In practice, this means monitoring integration errors, downtimes and agreed service levels. Modern integration platforms provide Business Activity Monitoring (BAM) functionalities which support this need.

7. CONCLUSIONS

The main objective of this thesis was to create an applicable integration framework to help with ITSM integrations. For observing the objective, two different perspectives were assigned: process and technology. They associated with the actual research questions presented next:

1. *What are the best practices for integrating an ITSM process with an integration partner?*
2. *How integration interfaces should be built to support the interoperability and the ease at maintenance?*

In the regard of the practical need, the action research approach was chosen to explore the research questions. This approach shaped the research process into the following form: theory, framework, implementation and analysis. In the theory part different literature sources were reviewed. Then the findings from theory were combined with researcher's practical experiences and were transformed into the ITSM integration framework. Further, the framework was used in ITSM integration implementation and, finally, the outcome of the framework was analyzed and evaluated.

The main results of this thesis were:

- Framework architecture
- Framework tools
- Implementation model
- Testing model
- Deployment model

This chapter evaluates the results that were presented in this thesis. The evaluation assess how well the research questions were answered and objectives were achieved. Then after evaluation, the chapter discusses about exploitation possibilities of the results. Finally, the last part of the chapter visions future potentiality of the framework.

7.1. Evaluation of Results

The newly created integration framework provided answers to the research questions but the second research question was not answered thoroughly. This was because the initially chosen perspective for ITSM integration framework seemed to increase ITSM tool dependency and technology itself. Therefore, the main focus of the thesis was shifted more over the first research question. This focus change altered the perspective of the thesis into a combination of project management and process oriented principles. Despite this, the second research question was not totally forgotten since it was answered on an architectural level.

The integration framework answers directly to the first research question since the framework provides ITSM integration best practices for project management, design, implementation and testing. As a fundamental best practice, the framework contained a four-division structure of architecture, process, data, and technology. This acted as a baseline for design, implementation and testing. The structure has its roots in the EA model (Huovinen et al. 2012, 69), ITIL technology management recommendation (OGC 2007b, 41) and TOGAF domains (Open Group 2009, 54, 61). Even though the structure is very simple, it summarizes the integration phases comprehensively at high level. Even people with zero knowledge of ITSM integrations can understand the overall process and phases included. Furthermore, the used literature references demonstrate that integrations should be seen as a part of the EA and not as separate interfaces. Another observation is that the service management principles presented by ITIL and other frameworks are applicable for integrations as well. This underlines the statement that integrations should be seen as services.

Currently the framework includes following tools:

- ITSM integration requirements pre-study template
- Use case template
- Dataflow diagram template
- Transaction definition template
- Integration framework presentation

These tools help to achieve the design objectives set by each section of the framework. Based on experiences, it is common that integration specifications are badly structured, complex and out-of-date. This makes specifications hard to understand and the integration partner ends up consuming valuable calendar time while struggling with the implementation details. This misalignment makes the integration work technology-oriented instead of business- and process-oriented. The framework tools address this problem with standard outcome documents. Therefore, the framework tools can be considered as best practices for ITSM integration design meaning that they are also part of the answer to the first research question.

The integration work requires process understanding but at the same time technical skills to perceive limitations of the technology. These skills are needed when the implementation and testing models are utilized. They present the practical side of best practices along with the deployment model. In fact, the implementation model and the technology interoperability recommendations are only parts of the thesis which answer to the second research question.

The implementation model recommends that the interface and the integration process should be implemented using SOA approach. This means that the code components are done in a reusable manner and with abstraction levels. Taking this approach makes the components generic enabling their reuse in different cases. This, on the other hand, saves implementation time. The implementation of abstraction layers means separating technology, data, process, and user interface levels. Because of this, the interface remains maintainable as fixes can be applied to certain level without breaking the overall solution. Furthermore, the technology interoperability recommendations presented in the table 2 illustrated what technologies should be preferred in order to maintain interoperability. The generic trend was to utilize Internet protocols and methods for communication. Finally, the last aspect to the second research question was data transformation presented by Spackman & Speaker (2005). This important part of the interface design is the part which is subjected to continuous changes because data mappings tend to change. Therefore, the data mapping should be maintained somewhere else than in the code. For example, a mapping table is a good place for this.

7.2. Exploitation of Results

The integration framework adapts to different integration needs. Therefore, the results of the thesis can be used differently in five different scenarios. The basic scenario is to use the framework as a project management tool for planning integration project phases and tasks. This is because the framework gives an overview of the complete integration project and illustrates what is required in each phase. The second scenario is to use the integration framework as an architecture tool for modelling SOA based solutions. The framework architecture is conducted from the Open Group's (2009) EA best practice model and OGC's (2007b) technology management recommendation using Erl's (2008b) SOA design principles. This makes the framework architecture also adaptable for building integration architectures. The third scenario is to use the integration framework as a reference integration design tool. This can be justified with the straightforward process and tools that the framework provides. The process tools, such as the use case template and the dataflow diagram template, are conducted from the process best practices by Burnstein (2003) and Holub (2000), ensuring that the design is carried out comprehensively. The fourth scenario is to use the framework as an implementation guide and a reference solution. The implementation model supports this by taking into consideration different layers of implementation which structurize the work into clear blocks. The model is based on Linthicum's (2000) and Open Group's (2009) best practice architecture. The last scenario is to use the framework as a testing tool. This is supported by the testing model which suggests a preferred approach for testing. This approach is conducted from the software testing best practices presented by Burnstein (2003) and Rick & Stefan (2002).

If the previous discussion is presented through roles, there would be five different ones using the integration framework. These are a project manager, an architect, a process designer, a developer, and a tester. Of course, the integration framework is also usable for executives due to its abstraction. This means that the framework can be used to visualize where the integration project is going and justifying different integration related considerations to the management.

As a conclusion, the integration framework is usable for any ITSM integration through different organizations but the adaptation level depends on the need and role. Further, the framework can be used as an informative tool to spread knowledge about ITSM integration best practices.

7.3. Future

Cummins (2009) described that the key drivers towards agile enterprise are task automation, EAI, the Internet, Web services and SOA. While the world is becoming more service-oriented, the need for service integration is increasing. This is also the case with the ITSM since IT service automation is becoming more popular. The generic integration framework answers to this need but, nevertheless, there are no shortcuts for ITSM integrations. Each integration requires careful planning, robust design, and quality in implementation. At least to this day, these phases could not have been automated.

While technology and business processes involve, the integration framework needs to keep up with the development as well. According to OGC (2007a), CSI aligns IT services to the changing business needs by reviewing and analyzing improvement opportunities. This best practice and ideology should be fostered in the integration framework as well. Even though the core structure of the framework is intended to remain unchanged, the design objectives and framework tools should be reviewed periodically to meet the future needs of ITSM integration. This will drive the framework towards its long-term objective of transforming it into the service management integration framework.

IT organizations would have easier ITSM integrations if every organization was using same kind of data. In practice, this is very challenging since each organization has its own distinctive processes which produce heterogeneous data. Despite this, there are similarities on the contextual level meaning that different organizations have named the same data differently. This raises an important question: how to create a common, universally accepted, data model between ITSM integration partners? One solution would be to agree about the core data and fields with extension possibility. However, the reason why this has not been succeeded, is the difficulty of engagement between IT organizations, vendors, suppliers and partners.

When thinking future trends, it is obvious that cloud services will strengthen their role in the ITSM landscape and within the whole IT sector. This can be seen through the rise of services that are provided over the Internet to private users and companies. For example, Amazon and Twitter provide these kind of services. Combining cloud services with organization's internal hosted systems requires new ways of thinking. Thus, an important question can be raised: how to enable the flexibility and service orientation among organization's scattered and partly hybrid resources? Even though the solution models for this question rely on the EA and SOA concepts, the dilemma is in architectural choices that need to support the enterprise agility now and in the future.

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APPENDICES

APPENDIX A

ITSM Integration Requirements Pre-study

This document is designed to be used to gather ITSM integration requirements for making design considerations about the integration approach, architecture and technology. The results of this pre-study require analysis by a person who has sufficient technical skills and ability to understand the process flow.

Company: Organization A
Company ITSM system: System X
Integration partner: Organization B
Integration partner system: System Y
Business need: To automate incident management process between integration partner and to enable reporting on incidents

Highlight the choices which describe the situation best.

1. What ITSM processes are integrated?
   [✓ a) Incident Management]
   b) Request Fulfillment
   c) Change Management
   d) Problem Management
   e) Access Management
   f) Service Asset and Configuration Management
   g) Service Catalogue Management
   h) Event Management
   i) Other? What?

2. What are expected volumes of transferred data (messages/files) approximately?
   a) Dozens per day or less
   [✓ b) Hundreds per day]
   c) Thousands per day
   d) Several thousands (10000 >) per day or more

3. Does the integration partner use middleware to integrate systems?
   a) Message Broker
   [✓ b) ESB]
   c) Other Middleware? What?
   d) No middleware is used

4. In which direction data moves between company and integration partner?
   a) One-way outbound: From company to integration partner
   b) One-way inbound: From integration partner towards company
   c) Two-way full: Data moves similarly in both directions in technical and process wise
   [✓ d) Two-way with restrictions: Data moves technically in both directions but there are limitations in process wise, for example, integration partner is not allowed to initiate the communication]

5. How data should be exchanged (integration style)?
   [✓ a) Transactional data exchange – One record per transaction or file exchanged nearly real-time]
   b) Batch job – Larger file containing multiple records run on a scheduled basis
   c) Event trigger – Interface starts the execution of predefined actions from the sent message

6. Are attachments exchanged in the integration?
   a) Yes
   [✓ b) No]

7. What endpoints does the integration partner system provide?
   a) Database endpoints
   b) File endpoints
   c) Application endpoints
   [✓ d) Web endpoints]

8. How the integration partner's system interface operates (PUSH vs. PULL)?
   [✓ a) Active (PUSH) – Interface is able to initiate communication]
   b) Passive (PULL) – Interface is NOT able to initiate communication

9. What communication models are available?
   a) One-to-one message passing
   [✓ b) Synchronous request/response]
   [✓ c) Asynchronous request/response with callback]
   d) Asynchronous request/response with polling
   e) Multicast message passing with publish/subscribe

10. What technology is supported by the integration partner interface?
   [✓ a) SOAP Web Service]
   b) REST Web Service
   [✓ c) HTTP, HTTPS]
   [✓ d) FTP, SFTP]
   e) JDBC
   f) ODBC
   g) LDAP
   h) Email
   i) Other? What?

11. What is the flexibility level of integration partner’s interface?

    a) Standard interface – No modifications allowed, except mappings

    b) Mass customized interface – Some modifications are possible but core functions are standard

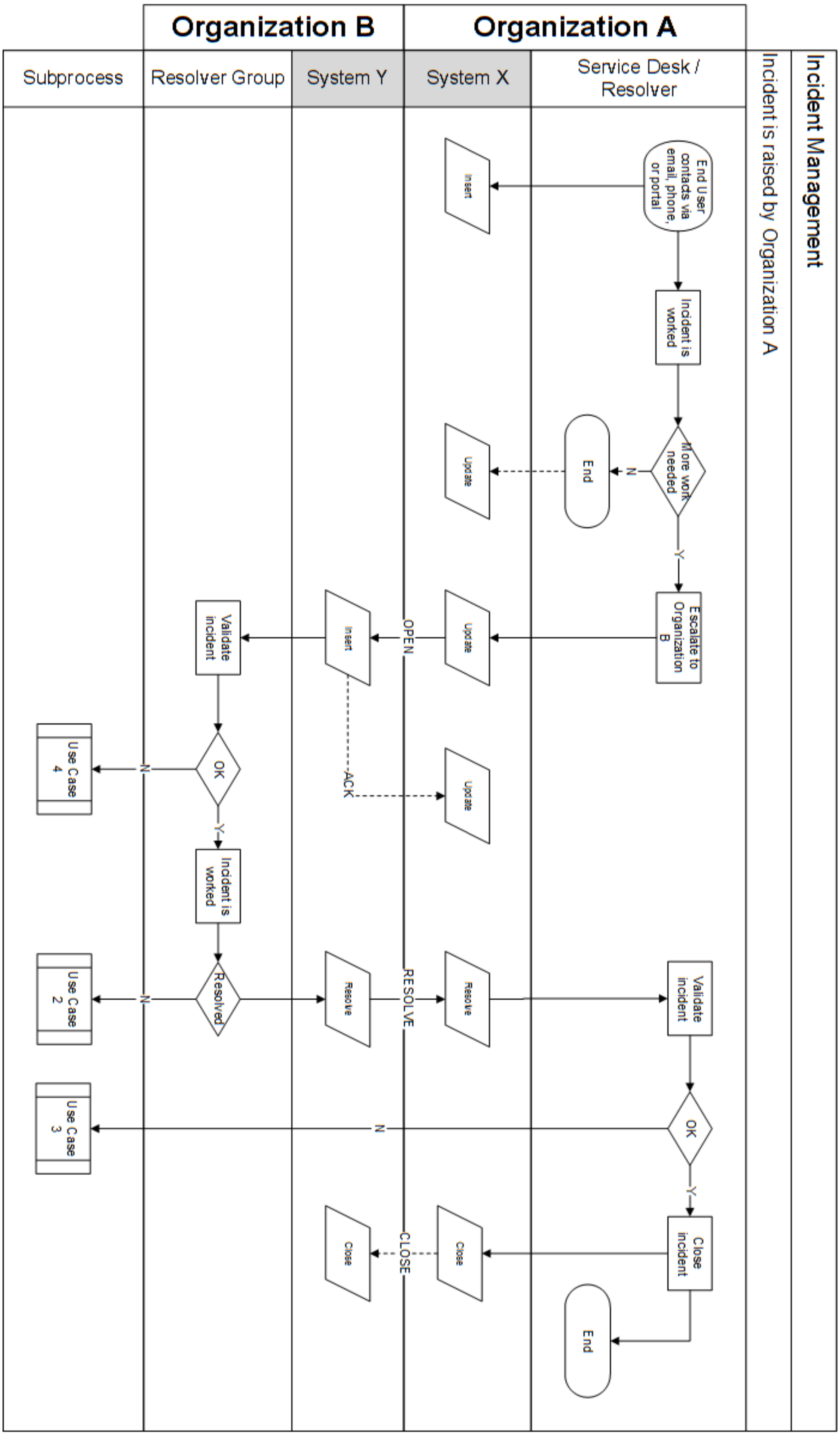
    c) Custom interface – Nearly all modifications are possible

APPENDIX B

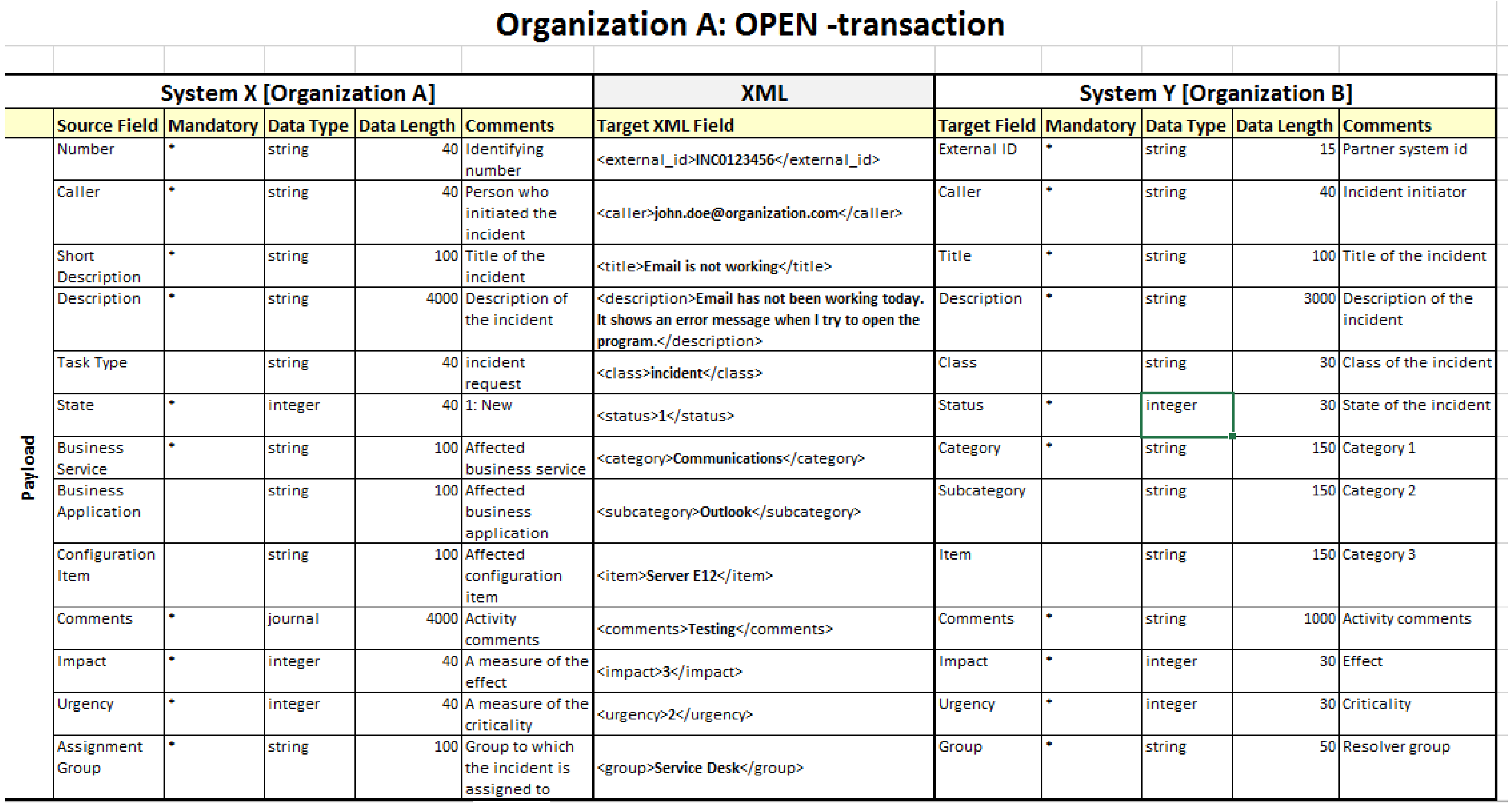
UC1: End user from the Organization A raises an incident

Description	Incident is created in the System X by the resolver from Organization A. The system X transfers the case into the system Y for resolving. The resolver from Organization B starts to work with incident and resolves it. The resolution is transferred back to the system X by the system Y. After this the resolver A accepts the resolution and closes the incident.
Business Event	Organization A needs organization B to resolve an incident
Actor(s)	- Organization A end user - Organization A resolver - Organization B resolver - System X - System Y
Precondition(s)	- System X and System Y are operational - Communication is working between the systems
Outcome (Success)	Incident is resolved by Organization B resolver
Outcome (Failed)	Incident is rejected/cancelled by Organization B resolver
Associations	UC2: Incident requires more information from Organization A to be resolved UC3: Incident requires more work from Organization B to be accepted UC4: Incident is rejected by Organization B resolver UC5: Incident is resolved by Organization A after it has been exchanged
Workflow	MAIN: 1. End user from the Organization A has faced an issue and he/she raises an incident via email, phone, or company portal. 2. The incident is created in System X. 3. The resolver A starts to work with the incident and notices that the incident requires special knowledge from Organization B. Therefore, the resolver A assigns the incident to the Organization B group. 4. The integration is triggered and the system X transfers the incident to the system Y. 5. The system Y automatically responses to this request with the newly created incident id. This id is then updated on the originally created incident in the system X. 6. Resolver B validates the new incident. 7. Resolver B resolves the incident and writes details about resolution in the incident. 8. The system Y transfers the updated resolution to the system Y. 9. The resolver A validates the resolution and closes the incident. 10. The closure information is updated to the system Y. ALTERNATIVE: A. Step 6: Incident is rejected by resolver B. Then UC4 is applicable. B. Step 7: Incident cannot be resolved with current information. Therefore, more information is required from Organization A. Then UC 2 is applicable. C. Step 9: Incident is not accepted by resolver A. Then updated information is sent back to resolver B through the integration and UC4 is applicable.
Notes	This use case describes the process mainly from the process view. For more detailed technical flow see the dataflow diagram and the related transactions.

APPENDIX C


Incident Management
Incident is raised by Organization A
Organization A
Organization B
Service Desk / Resolver
System X
System Y
Resolver Group
Subprocess
End User contacts via email, phone, or portal
Insert
Incident is worked
More work needed
N
End
Update
Y
Escalate to Organization B
Update
OPEN
Insert
Validate incident
ACK
Update
OK
N
Use Case 4
Y
Incident is worked
Resolved
N
Use Case 2
Resolve
RESOLVE
Resolve
Validate incident
OK
N
Use Case 3
Y
Close incident
Close
CLOSE
Close
End

APPENDIX D



Organization A: OPEN -transaction

	System X [Organization A]					XML	System Y [Organization B]				
	Source Field	Mandatory	Data Type	Data Length	Comments	Target XML Field	Target Field	Mandatory	Data Type	Data Length	Comments
Payload	Number	•	string	40	Identifying number	<external_id>**INC0123456**</external_id>	External ID	•	string	15	Partner system id
	Caller	•	string	40	Person who initiated the incident	<caller>**john.doe@organization.com**</caller>	Caller	•	string	40	Incident initiator
	Short Description	•	string	100	Title of the incident	<title>**Email is not working**</title>	Title	•	string	100	Title of the incident
	Description	•	string	4000	Description of the incident	<description>**Email has not been working today. It shows an error message when I try to open the program.**</description>	Description	•	string	3000	Description of the incident
	Task Type		string	40	incident request	<class>**incident**</class>	Class		string	30	Class of the incident
	State	•	integer	40	1: New	<status>**1**</status>	Status	•	integer	30	State of the incident
	Business Service	•	string	100	Affected business service	<category>**Communications**</category>	Category	•	string	150	Category 1
	Business Application		string	100	Affected business application	<subcategory>**Outlook**</subcategory>	Subcategory		string	150	Category 2
	Configuration Item		string	100	Affected configuration item	<item>**Server E12**</item>	Item		string	150	Category 3
	Comments	•	journal	4000	Activity comments	<comments>**Testing**</comments>	Comments	•	string	1000	Activity comments
	Impact	•	integer	40	A measure of the effect	<impact>**3**</impact>	Impact	•	integer	30	Effect
	Urgency	•	integer	40	A measure of the criticality	<urgency>**2**</urgency>	Urgency	•	integer	30	Criticality
	Assignment Group	•	string	100	Group to which the incident is assigned to	<group>**Service Desk**</group>	Group	•	string	50	Resolver group