Enterprise Architecture for Decentralized Environments

Thomas Speckert

Department of Computer and Systems Sciences

Degree project 30 HE credits

Degree subject: Computer and Systems Sciences

Degree project at the Master level

Spring 2013

Advisor: Jelena Zdravkovic

External advisor: Irina Rychkova

Reviewer: Janis Stirna

Swedish title: Företagsarkitektur för Decentraliserade Miljöer

Stockholm University

Enterprise Architecture for Decentralized Environments

Thomas Speckert

Abstract

The problem of business-IT alignment is an important issue for modern organizations. Solving it allows all components of an organization to operate together in a collaborative manner for the purpose of maximizing overall benefit to the enterprise. Enterprise Architecture (EA) is a discipline that aims to solve this problem in a holistic manner from the ground up through proper design.

This thesis addresses the problem of a suitable EA for decentralized organizations and seeks to answer two research questions: 1) What aspects of existing EA frameworks support decentralized organizations? What aspects do not? and 2) What are the principles of an EA framework that supports decentralized organizations?. A design science research strategy has been followed in combination with interviews and document studies from a case study for data generation, and a qualitative approach to data analysis. The results of this were: specific shortcomings of the existing EA frameworks of Zachman, FEA, TOGAF with respect to organizational decentralization, based on a literature review; the detailing of mismatches between the case organization's implicit EA and their organizational structure; the elicitation of requirements for an EA artifact addressing these shortcomings; the development of a generic EA artifact for IT governance based on the peer-to-peer principle of *peer production*; and the demonstration of this artifact on the case organization. The demonstration showed that the proposed artifact offered advantages over traditional EA suggestions as it is able to better match the decentralized components of the case organization's organizational structure.

Keywords

Contents

List of Tables

List of Figures

1. Introduction

1.1 Background

Large enterprises have traditionally implemented formal, centralized forms of organizational structure [2], such as hierarchical or matrix structures. In these structures, communication patterns, roles and decision rights are strictly defined. This allows for management to have a high degree of control over the enterprise and therefore enforce compliance with standards, procedures and policies which results in a highly stable enterprise. However, this comes at the expense of agility; it is difficult for these organizations to quickly adapt to a changing environment. While centralized structures were appropriate for the business environments of the past, modern business environments demand a high level of agility.

Common components of modern business environments include cooperation with different organizations, rapidly changing business activities and processes, and a rapidly changing competitive landscape. In order to properly handle these components, a high level of enterprise agility is necessary. In centralized organizations, decisions need to be discussed at all levels of the hierarchy in order to obtain the appropriate justification and approval. This takes time; by the time a decision is made, it is often too late for it to be effective. In contrast, having decision making on the operational level allows for quick decisions that enables an organization to take advantage of opportunities quickly. More decentralized structures, such as networked organizations [2], are examples of this. It is important to note that a lack of rigidity and formal structure does not mean a lack of organization. It is still important for a decentralized enterprise to maintain order in its activities; this organization just needs to be based on an underlying decentralized structure instead of centralized one. Consequently, decentralized organizations need solutions to the same problems faced by centralized organizations – such as business-IT alignment – but the solutions need to be supportive of decentralization over centralization.

Decentralization and agility in organizations needs to be supported by IS. IS architectures exist that can support decentralization, for example Service-Oriented Architecture (SOA), but organizations need to use them to implement IS that is supportive of the organization. This issue of alignment between business and IT is one that is addressed by the practice of Enterprise Architecture (EA).

Enterprise Architecture is a practice for creating an architecture for an entire enterprise or organization. EA takes a holistic view of an enterprise in order to bring its many components – such as goals, strategies, information systems, processes, and governance styles – into alignment with each other. Many different EA frameworks currently exist, for example The Open Group Architecture Framework (TOGAF) [1], the Zachman Framework [3] and Federal Enterprise Architecture (FEA) [4].

All frameworks address one or more of the following three different aspects: artifacts that describe an enterprise's architecture, the process of creating these artifacts, and a way to ensure that the architecture implementation is an ongoing success. In this thesis, these three elements are respectively referred to as the EA description, EA method, and EA engine (Fig 1.1).

By creating an architecture for all components of an enterprise, EA is a solution to the problem of business-IT alignment. Therefore, in this thesis we analyze modern
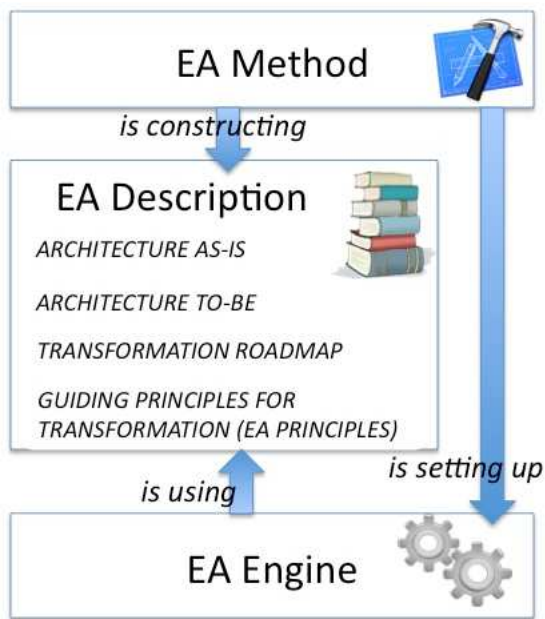
Figure 1.1: Enterprise Architecture

EA frameworks for their support of decentralization in organizations. Support for decentralization in EA frameworks would allow for EA to be a solution for business-IT alignment in decentralized organizations.

1.2 Problem

The problem of business-IT alignment is relevant for all types of organizations, regardless of whether they have a centralized or decentralized structure. Solving it allows all components of an enterprise to operate together in a collaborative manner for the purpose of maximizing overall enterprise efficiency. Enterprise Architecture frameworks outline a formal way in which to solve this problem. This thesis argues, however, that modern EA frameworks are primarily supportive of centralized organizations, and as such, have some shortcomings when applied in decentralized organizations.

Many modern organizations are becoming increasingly decentralized in order to deal with increasingly dynamic business environments [5]. Modern EA frameworks and methodologies need to be able to handle these environments, and while they often can, rapidly changing business conditions have been identified as a critical problem in EA [6, 7]. In [8, Ch. 1], situations were identified where "EA fails to keep pace with the speed of change in modern business" and "companies that, despite having a fully institutionalized EA in place, were in a state close to paralysis". In [9], Najafi and Baraani state that a main challenge of existing EA frameworks is that they are "inflexible to perceive business changes or opportunities and then change appropriately to adapt and adopt these changes".

Furthermore, current EA frameworks rely on some organizational properties that are becoming obsolete with progressive decentralization. For example, TOGAF [1, Ch. 47] suggests an approval process based on hierarchy, with an Architecture Board responsible for decision making; and FEA sets enterprise-wide standards to be followed by all through a set of common reference models [10]. For these reasons, ensuring the

suitability of modern EA frameworks for decentralized business environments–which are highly dynamic–is becoming increasingly relevant.

This thesis addresses the problem of a suitable EA for decentralized organizations. The goal is not to create a new EA framework, but rather to enhance existing ones through guidelines or principles that increase their support for decentralized business environments.

An important part of this thesis project is to analyze the suitability of existing EA frameworks for decentralization. Therefore, the problem will be fully explicated–including a precise definition, problem motivation, and root cause analysis–in the results chapter, Section 4.1.

1.3   Research Questions

The two research questions for this thesis are:

1. What aspects of existing EA frameworks support decentralized organizations? What aspects do not?

2. What are the principles of an EA framework that supports decentralized organizations?

1.4   Limitations

A subset of identified issues with EA will be addressed. This is specified in Section 4.3.

1.5   Chapter Layout

This paper is structured as follows:

Chapter 2 - Extended Background An extended background on decentralization in organizations and on three modern EA frameworks is presented here. Additionally, the related subjects of Enterprise Integration and Enterprise modeling are covered as related works.

Chapter 3 - Method This chapter contains: a justification for following design science; the chosen research methods and strategies along with reasons for these choices and a discussion of alternatives; how these methods and strategies are actually applied for this research; and lastly ethical considerations are covered.

Chapter 4 - Results This chapter contains: an explication of the problem with how the EA frameworks of TOGAF, Zachman, and FEA support decentralization; an explication of the problem with the case organization's support for EA; an outline of the solution artifact, which takes the form of guidelines (method artifact type [11, Ch. 2.4]), and its accompanying requirements; the design of the artifact, which was performed with the aid of knowledge on peer-to-peer architectures; a demonstration of the artifact based on a case study; and an argumentative evaluation of the artifact through it's demonstration.

Chapter 5 - Conclusions & Discussions This chapter describes the primary conclusions drawn from the results, a discussion of the validity of the results, a discussion of ethical and societal consequences, and recommendations for future works.

2. Extended Background

2.1 Enterprise Architecture

According to Sessions [10], the field of Enterprise Architecture (EA) emerged in order to combat two increasingly prevalent problems facing enterprises: system complexity and business-IT alignment. As enterprises rely more and more on information systems of increasing complexity, these problems become even more important. The field of EA views the solution to these problems to be one of concurrent design. It is not enough simply try and fit IT to the business; business and IT aspects should be designed concurrently.

While there is no singular agreed-upon definition for EA, different definitions [1, 2, 10, 12–15] do have much in common. EA is a discipline that takes a holistic approach to transforming high-level business vision and goals into the integration of an enterprise's organizational structure, business processes, and information systems. This transformation involves identifying and implementing the necessary change for this to occur. In order to view different EA frameworks from a common perspective, this thesis will break them down into three separate components that contribute to this transformation: the EA method, the EA description, and the EA engine (Figure 1.1).

The Method aims to lay the groundwork for the EA project. Typically, this involves setting up teams, ownership, responsibilities and gaining commitment. Also it defines the overall process of collecting, validating and approving the EA artifacts (e.g. descriptions As-Is, To-Be, gap analysis, principles) that will form the second component - The EA description. The Engine involves setting up a support structure for ensuring the ongoing adoption of the to-be EA description. This can involve gaining commitment fr om stakeholders, setting up some compliance checking procedures, and deciding upon a prioritization of tasks to be completed. The remainder of this section will look at three different EA frameworks from the perspective of of these three phases: The Open Group Architecture Framework (TOGAF), the Zachman Framework, and the Federal Enterprise Architecture (FEA).

2.1.1 TOGAF

The Open Group Architecture Framework, more commonly know as TOGAF, is a freely available EA framework created by The Open Group[1], a consortium of IT organizations. TOGAF is comprised of a number of different aspects, mainly: the Architecture Development Method (ADM), "a method for developing and managing the lifecycle of an enterprise architecture" [1, Ch. 5.1]; the Architecture Content Framework, a companion to the ADM which describes the content of the products of the ADM; the Architecture Landscape and Enterprise Continuum, which provide a means to organize the produced architectures; a set of reference models; and the Architecture Capability Framework, a set of "reference materials" for successfully operating an "architecture function" within an enterprise [1, Ch. 45].

---

[1] www.opengroup.org
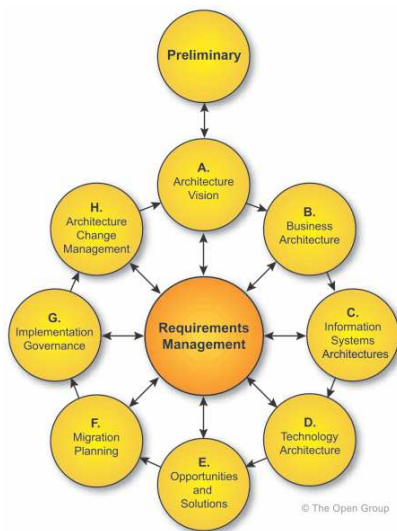
Figure 2.1: TOGAF: ADM basic structure from [1, Sec. 5.2.2]

EA Method

The TOGAF ADM falls under our EA Method component of EA. The TOGAF ADM is made up of a preliminary phase, six core phases (labeled A-H), and a requirements management component.

In TOGAF, the preliminary phase lays the groundwork for the rest of the EA process. Some important aspects are to set up a governance structure and EA team for the EA process and to establish a repository for storing all architectural information [1, Ch. 6].

Phase A of the TOGAF Process, the architectural vision phase, is aimed at setting a clear vision for the enterprises future architecture. This involves creating the initial as-is architecture as well as setting clear, management approved goals and requirements, and transforming them into a high-level vision of the enterprises to-be architecture [1, Ch. 7].

At this point, TOGAF suggests that the outputs of the preliminary phase and phase A be organized into a "Statement of Architecture Work". This document is to be approved by project sponsors [1, Sec. 7.4.11] and can be used to form the basis of a contract between the architecture provider and the client [1, Sec. 36.2.20].

The next three phases, B-D are concerned with creating the as-is and to-be business architecture, information systems architecture, and the technology architecture [1, Ch.8-12]. TOGAF suggests two different approaches to creating the architectures: baseline first or target first [1, Ch. 19.4]. Baseline-first involves analyzing the as-is architecture for areas where improvements can be made. Target-first aims at creating a detailed target architecture and then mapping it back to the as-is architecture in order figure out what needs to change. The main aspects of these phases are to develop the as-is and to-be architectures, analyze the gap between them, and create an initial road-map of the steps needed to cross the gap.

Phase E and F, Opportunities and Solutions and Migration Planning, are concerned with organizing the work to be done into projects, and then creating a schedule for executing the projects [1, Ch. 13-14].

Phase G is concerned with the implementation and setting up a framework for its governance and its compliance to the target architecture [1, Ch. 15].

EA Description

TOGAF views architecture from the perspective of four different architecture domains [10]: business, application, data, and technical. Business architecture is concerned with processes and functions used to meet business goals, application architecture is concerned with the design of specific applications and their interactions, data architecture is concerned with managing enterprise data, and the technical architecture is concerned with the infrastructure (hardware and software) used to support the applications. The architectures in these four domains are created through the ADM phases B (Business Architecture Phase), C (Information Systems Architectures Phase) and D (Technology Architecture).

Architecture Landscape

The various architectural artifacts in TOGAF are organized across an Architectural Landscape [1, Ch. 20] of three dimensions: breadth, level, and time. Breadth refers to the area of subject matter for an architecture. Levels refer to the level of detail of an architecture. TOGAF specifies three levels of detail: strategic, for overall direction setting at the executive level; segment, for architectures at the level of a program or portfolio; and capability, for architectures concerned with how the architecture process is itself enabled and governed. The time dimension of the landscape keeps the state of architectures as they evolve over time. Additionally, the Architecture Landscape can be partitioned into independent partitions for supporting different organizational units [1, Ch. 40].

Enterprise Continuum

At each level of the Architecture Landscape, architectures are further organized through the Enterprise Continuum which provides a way to organize the architectures from generic to organization-specific [1, Ch. 39]. The most generic are called Foundation Architectures [1, Ch. 39.4.1], which are applicable to all enterprises. A core aspect of a Foundation Architecture is to provide a high-level taxonomy which can provide a basis for the more specific architectures [1, Ch. 43].

The second set of architectures in the continuum are called the Common Systems Architectures [1, Ch. 39.4.1]. These architectures are specific to a generic problem domain (e.g. security management), and are thus applicable to a wide range (but not all) of enterprises.

The third set of architectures in the continuum are called Industry Architectures. These architectures are applicable to a specific problem within a specific industry. They are thus useful to many members of that industry, but not necessarily outside of it. The most specific level in the continuum are Organization-Specific architectures. As the name implies, they are relevant only to a specific enterprise. These outline the architectural solution for a particular enterprise and provide "a means to communicate and manage business operations across all four architectural domains" [1, Ch. 39.4.1].

Reference Models

TOGAF includes two reference models. The Technical Reference Model (TRM) is a Foundation Architecture which describes a number "of generic services and functions that provides a foundation on which more specific architectures and architectural components can be built" [1, Sec. 43.1.1]. The second provided reference model, the Integrated Information Infrastructure Reference Model (III-RM), is a subset of the TRM and is
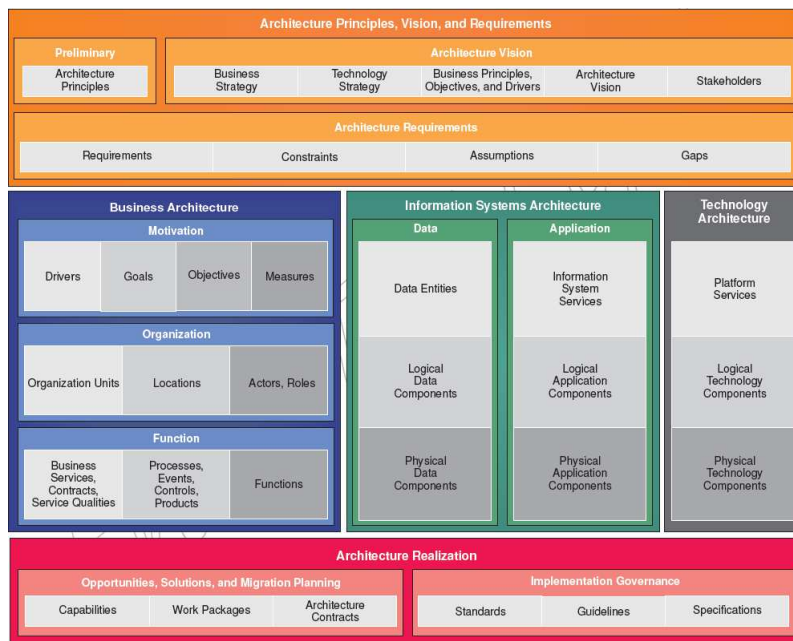
Figure 2.2: TOGAF: Content Metamodel from [1, Sec. 34.2]

classified as a Common System Architecture on the Enterprise Continuum [1, Ch. 44]. The III-RM is a reference model for enabling information integration across an enterprise.

Architecture Content Framework

The Architecture Content Framework (ACF) describes the outputs of the architecture efforts from the TOGAF's method, the ADM. The content of the outputs is described by the Content Metamodel [1, Ch. 34], which is summarized in Figure 2.2. The outputs can are seen from three different viewpoints [8, Ch. 4] described by the content framework: deliverables, artifacts, and building blocks [1, Ch. 33]. A *deliverable* is an output that is specified in the architecture contract, and is therefore subject to formal review and sign-off. A deliverable is composed of one or more *artifacts* which describe some aspect of the architecture. Artifacts, in turn, describe *building blocks*, which represent either: a) a specific functionality of the enterprise, or b) an actual component which implements a specified functionality.

EA Engine

The engine component TOGAF is composed of an on-going change management process and a framework for managing architecture capability in an enterprise.

Architecture Change Management

The final ADM phase, phase H, outlines an ongoing change management process for the architecture of an enterprise. It is concerned with managing changes to the architecture throughout its lifecycle [1, Ch. 16]. In this phase, a governance body sets criteria for determining if a change requires an architecture update if a new cycle of the ADM needs to be started. An important aspect of this process is to deploy tools for monitoring for business and technological changes and measuring performance indicators.
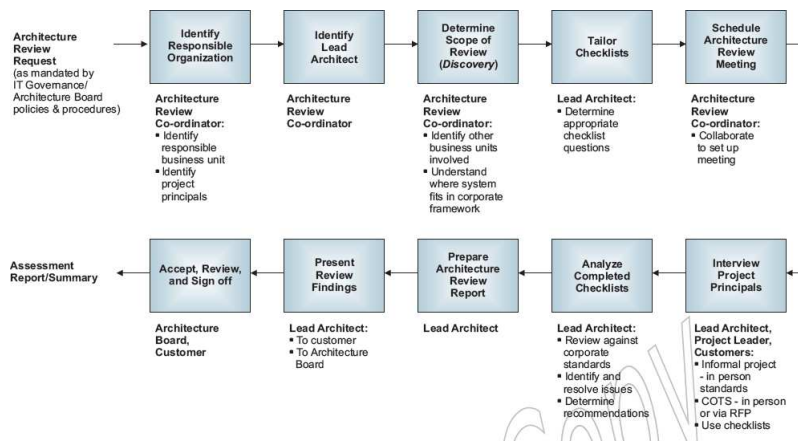
Figure 2.3: TOGAF: Architecture Compliance Review Process from [1, Sec. 48.4.1]

Figure 2.4: TOGAF: Architecture Governance Framework – Organizational Structure from [1, Sec. 50.2.2.1]

Architecture Capability Framework

TOGAF describes its Architecture Capability Framework as providing a set of reference materials for creating appropriate "organization structures, processes, roles, responsibilities, and skills" in order to "successfully operate an architecture function" [1, Sec. 45.1]. Key components of this framework are the creating of an Architecture Board, a formal architecture compliance process, the use of architecture contracts, and guidelines for architecture governance.

The Architecture Board is responsible for overseeing architecture governance activities. Specific responsibilities include "[p]roviding the basis for all decision-making with regard to the architectures", ensuring the various partitioned architectures are consistent, and enforcing compliance [1, Ch. 47].

TOGAF describes a formal review process for determining compliance. The main goal of this process is to "[f]irst and foremost, catch errors in the project architecture early, and thereby reduce the cost and risk of changes required later in the lifecycle" [1, Ch. 48.3.1]. This process is outlined in Figure 2.3.

TOGAF suggests the use of contracts between architecture developers and sponsors (i.e. the party who wants the architecture) in order to have a formal agreement on the "deliverables, quality, and fitness-for-purpose" [1, Ch. 49]. The goal of having contracts is to guarantee: continuous monitoring of architecture decisions, changes, and integrity; adherence to architecture "principles, standards and requirements"; that all risks are identified; the existence of processes to ensure "ensure accountability, responsibility, and discipline"; and a formal definition of governance and decision-making authority. Adherence to the contracts is guaranteed by architecture governance.

In TOGAF, "architecture governance is an approach, a series of processes, a cultural orientation, and set of owned responsibilities that ensure the integrity and effectiveness of the organization's architectures" [1, Ch. 50].The suggested organizational structure for governance involves three separate phases–Develop, Implement, and Deploy–supported by the Enterprise Continuum, and overseen by a CIO/CTO. In order for the architectural effort to be successful, the architecture governance strategy needs to specify an Architecture Board, a set of architecture principles, and ensure compliance.

2.1.2 The Zachman Framework

The Zachman Framework was the first EA, first introduced by John Zachman in 1987 [3, 10]. It consists only of a taxonomy, and as such only fits into the EA Description aspect of EA.

EA Method and Engine

Despite not specifying an engine or method for use with ZF, these components are still necessary for a successful EA effort. ZF can be used however an organization wishes, though some formal guidelines do exist for its use. One option is to fit ZF into another EA framework, replacing that framework's EA description with ZF. TOGAF, for example, states that it is possible to replace the TOGAF content framework with ZF [1, Ch. 33]. A second option is pay for formal training from Zachman International [16], where it is possible to get certified in the use of ZF. A third option is through hiring a consultant who is already familiar with ZF. Zachman International, for example, offers consulting services.

EA Description

The Zachman Framework (ZF) breaks down EA into a grid of perspectives. Each perspective is characterized by two things; its target audience and the issue is aimed at. ZF covers six issues: What (data and entities), How (functional), Where (locations and interconnections/networks), Who (people relationships), When (events and performance criteria), Why (motivations and goals) [12]. For each issue, it views it from six different perspectives: executive, business management, architect, engineer, technician, and enterprise users.

The executive perspective is meant for executives or planners and needs to provide an estimate of a system's functionality and cost [12]. The business management perspective is a business view of how an owner thinks the business operates [17]. The architect perspective takes a systems viewpoint and describes the operations and interactions of the variety of systems in an enterprise. The engineer perspective views describes the physical technology and design of the individual systems. The technician perspective takes the perspective of a "sub-contractor" who is implementing a specific system and the high, out-of-context level of detail associated with that. The enterprise users perspective describes the perspective of the people who actually use the system.

2.1.3 Federal Enterprise Architecture

The Federal Enterprise Architecture (FEA) is an effort by the federal government of the United States to create an EA for the entire government. The FEA is a complete EA framework, covering all three components of EA. The Federal Enterprise Architecture Program Management Office describes FEA as "...a common language and framework to describe and analyze IT investments, enhance collaboration and ultimately transform the Federal government into a citizen-centered, results-oriented, and market-based organization as set forth in the President's Management Agenda." [4] FEA takes takes an approach where individual organizational units develop their own architectures that fit into an overall framework of common standards and interoperability.

FEA is composed of six core elements [10]:

- The organization is broken-down into different segments of varying scopes, and architecture is developed for each segment

- A set of five reference models which are used as a basis to describe the important elements of the FEA in a consistent manner

- A process for creating each segment EA

- A transitional process for moving from the current state of the enterprise to the visioned state

- A taxonomy for organizing the various assets of the FEA

- Guidelines for measuring the degree of success of the FEA

Compared to TOGAF and Zachman Framework, FEA defines both the taxonomy for EA artifacts (EA description in Fig. 1.1) and the EA process for creating these artifacts and using them by organization (EA method and EA engine in Fig.1.1).

EA Description

FEA develops architecture for segments and enterprise services. A segment is a "major line-of-business functionality" [10] for an individual organizational unit (such as an agency or department). Two types of segments exist: core mission-area segments and business service segments [4]. Core mission-area segments are at the scope of a single organizational unit (though they may be shared by different units) and are essential to its purpose [4, 10]. Business service segments are also at the scope of an individual organizational unit, however these segments exist in all organizational units and are defined for the entire enterprise. Like business service segments, enterprise services are defined organization-wide. However, they are different in that they also function at the enterprise level, e.g. a single security management service that is shared by the entire enterprise.

The EA artifacts defined by FEA include baseline segment architectures, target segment architectures and transition strategy. The EA transition strategy describes the overall plan and schedule to achieve the target ("to-be") architecture.

In order to have a common language for describing the enterprises assets, FEA describes five reference models for mapping assets to segments and enterprise services [4]. The five reference models are the performance reference model, the business reference model, the service component reference model, the technical reference model, and the data reference model.

The performance reference model provides a framework for developing consistent measurement. The business reference model provides a framework for developing a functional view of the enterprises line of business. The service component reference model provides a framework for describing how the services offered by IT systems support business functionality. The data reference model provides a framework for describing data in a consistent way that enables enterprise-wide sharing.

EA Method

FEA defines a four step iterative process for creating architectures for each segment and service [4]:

1. Architectural analysis

2. Architectural definition

3. Investment and funding strategy

4. Program management plan and execute projects

The first step, architectural analysis, is concerned with defining the scope of the segment, its baseline architecture, current problems in the segment, and a high-level vision of the desired final state for the segment [4].

The second step, architectural definition, is concerned with defining the detailed target architecture of the segment [4]. Aside for the architecture itself, it is also necessary to define a roadmap of projects to get there, the segment transition strategy, and the performance goals of the architecture.

The third step, the investment and funding strategy, is concerned with specifying how the projects identified in the segment transition strategy are to be funded [4].

The fourth step, program management plan and execute strategies, is concerned with making detailed plans for the individual projects, executing the plans, and defining performance measurements for the initiative [4].

EA Engine

FEA describes an activity to maintain the architecture in order ensure that it stays relevant over time. FEA calls this activity "segment architecture maintenance" [4]. In this activity, it is important to monitor for, list and prioritize new architectural change drivers as they appear. The impact of these drivers needs to be defined.

FEA defines an EA value measurement process: "a continuous, customer- focused process relying on feedback from EA stakeholders and other value measures to increase the quality and effectiveness of EA products and services to support business decisions" [4, Sec. 5].

FEA describes "EA governance and management processes" [4, Sec. 2] to control architecture development. These process are implemented to manage standards, enforce compliance, manage collaboration between agencies, approve architectures for implementation, and manage business and IS requirements for managing EA change.

2.2   Decentralization in Organizations

This section will first discuss the forms of organizational structure defined in the literature. Second, the (de)centralization of current organization and, as a consequence, their styles of IT governance will be explored. We conclude this section by underpinning the challenges organizations have to face due to their progressive decentralization.

2.2.1   What is a Decentralized Organization?

An organization can be structured in many different ways. Sachdeva [18] defines organizational structure as "... institutional arrangements and mechanisms for mobilizing human, physical, financial and information resources at all levels of the system..." According to Jacobides [19], "Organizational structure provides the frames through which individuals see their world. Thus, the way each organization is structured shapes an ecology of different, distinct frames that exist at the level of the organizational sub-unit."

There has been a lot of research on specific forms of organizational structure. Taxonomies of organization forms are defined in [20], [21]. *Classic* and *modern* types of organizational structure are often recognized. Classic types include simple centralized organizations [22], bureaucratic organizations [23], divisional structure and functional structure. Modern types include matrix structure, flat organizations, adhocracy. New forms of organizational structure emerged recently: collaborative networks, virtual organizations and coopetition.

According to Robbins [24], organizational structure has three components: complexity, formalization and centralization. Complexity refers to the degree to which activities within the organization are differentiated; Formalization refers to the degree to which work is standardized; Centralization refers to the degree to which decision making is concentrated at one point in the organization.

Following Luthens [25], centralization and decentralization can be also defined according to three factors: geographical or territorial concentration or dispersion of operations; functions; extent of concentration or delegation of decision making powers. In [2], the following characteristics of centralization are defined: the allocation of decision rights, the structure of communication lines and the choice of forms of coordination.

In a centralized organization, all decision making authority would reside with a single, top-level authority. In a completely decentralized enterprise all members would have equal decision making rights. Here, hierarchy manages the interdependencies between the different sub-units of organization and often makes direct interactions and communications unnecessary [26]. Decentralized organizations instead have less formalized communication lines [2, 27], and more fluid, project oriented teams. [28]

Centralized organizations lean towards primarily vertical style of coordination [29], which is characterized by formal authority, standardization and rules in operations and in IT, and planning and control systems. Decentralized organizations lean towards lateral coordination characterized by meetings, task forces, coordinating roles, matrix structures, and networks [29].

Below, popular forms of organizations focusing on their degree of centralization will be considered.

2.2.2 Forms of Organizational Structure and Decentralization

Classic Organizational Structures

Pearlson and Saunders offer a thorough description of a pure hierarchical organization structure [2]: Except for the top level position, each position has one superior and zero or more subordinates. Decision rights and communication lines are strictly defined and work their way down from the top (i.e. the centre). The scope of a position is specialized and strictly defined by your superior and one works in assigned teams. The primary benefit of a hierarchy is that the high levels of management have strict governance and control over the company. Hierarchical organization structures are suited for stable, certain environments.

Hierarchical organizations can be subdivided into simple centralized and bureaucratic organizations:

In simple centralized organizations, both strategic planning and operational decision making authority belongs to one person at the top. This structure can be found in small and single-person-owned organizations with only two hierarchical levels.

Bureaucratic organizations [23] are characterized by multi-level hierarchical structure and use of standard methods and procedures for performing work.

Hierarchical organizations generally divide their labor either in terms of function, a grouping of common activities, or in terms of division, a grouping based on output (product). Two organizational structures, divisional and functional, can be identified accordingly.

Modern Organizational Structures

Matrix structure is another popular style of organization structure [2] that can be seen as a mixture of functional and divisional structures. In this form, individuals are assigned two or more supervisors covering different (usually product and functional) dimensions of the enterprise. Pearlson and Saunders state that matrix organization structures are suited for dynamic environments with lots of uncertainty, presumably because their authority structure allows them to cover multiple aspects when making decisions. However, like a hierarchical structure, a matrix structure is a rigid construct with strictly defined roles, communication lines and decision rights. Authority still comes from the top in a centralized manner, even though it becomes more distributed among matrix managers at the lower levels [2].

Flat organization is a novel type of organizations where only one or maximum two hierarchical levels are defined (similarly to simple centralized organizations). For example, Valve Corporation, a software company in the video game industry released their handbook in 2012 [30]. Unlike simple centralized organization described above, individual employees have complete freedom despite there being a president/founder at the top: Nobody reports to anyone, and everyone is free to work on whatever they want to. This is an example of high decentralization.

Adhocracy [2, 28] aims to discard traditional hierarchies in favor of decentralized decision rights and flexible communication lines connecting the entire enterprise. Specifically, instead of hierarchies, an adhocracy has a rapidly changing set of project oriented groups that have decision making authority and other powers [24]. Mintzberg describes an adhocracy as "a loose, flexible, self-renewing organic form tied together mostly through lateral means" [22].

Post-Modern Organizational Structures

New forms of organizational structure enabled uniquely by modern information and communication technologies Internet emerged recently: collaborative networks [31] and coopetitions [32].

Related to the idea of adhocracy, is the concept of collaborative networks (CN). Camarinha-Matos and Afsarmanesh define collaborative networks as being composed of "a variety of entities (e.g., organizations and people) that are largely autonomous, geographically distributed, and heterogeneous in terms of their: operating environment, culture, social capital, and goals." [31] Three common characteristics in various CNs are autonomy in the individual entities, a drive towards meeting common or complementing goals, and the use of an agreed-upon framework for collaboration.

Under the umbrella of CNs, Camarinha-Matos and Afsarmanesh define virtual organizations, virtual communities, and virtual breeding environments [31]. Virtual organizations are a group of independent organizations working together to achieve some goal(s); virtual communities are communities of individuals that interact with each other through the use of computer network-based technologies; and virtual breeding

environments are frameworks for inter-operability set up by groups of organizations in order to enable the potential for forming a virtual organization.

Another organizational form emerged recently is coopetition. Bengsston and Kock describe coopetition as a complex relationship between firms where they simultaneously compete and collaborate and benefit from both [32]. Coopetition allows the participating organizations to take advantage of a heterogeneity of resources. Organizations may seek to create competitive advantage through a unique resource they own (e.g. skill). At the same time, it might be beneficial for them to cooperate with another organization that possesses a unique resource that is of value to them.

Virtual organizations and coopetitions differ from the organizational structures defined above since they do not represent a single legal entity but a group of autonomous and independent entities with different (and possibly concurrent) strategic goals. These entities are engaged into collaboration in response to factors such as specific market situations, customer demand, etc. The heterogeneous structure of such organizations remains invisible for a customer, while the service level agreements should be maintained at the same high level any other organization would maintain. Such organizational structures are grounded on a sustainable collaboration between partners without any centralized control.

Decentralization in Organizational IT

According to Rockart et al. [33], changes in business and technology as well as progressive decentralization of organization as a whole drives the changes in roles and structure of IT units. The works presented in [5, 33–35] focus on the relation between the structure of an organization and its IT.

Fulk [5] discusses the interplay between communication technology and various organizational forms. The authors consider communication technologies as one of the key enablers of inter-organizational and intra-organizational changes.

In [34], authors study how different organizational forms affect the knowledge transfer in organization. They claim that "Organizational forms enable different kinds of motivation and have different capacities to generate and transfer tacit knowledge."

Weill [35] defines six forms of organizational structures in IT (called IT Governance archetypes) based on how the five major IT decisions in organizations are made. These archetypes are: business monarchy, IT monarchy, feudal, federal, IT duopoly and anarchy. In a *business monarchy* all IT related decisions are made in a centralized manner by the top-level executives (e.g. the CxOs). In an *IT monarchy*, a group of IT professionals are responsible for making the decisions. This is also highly centralized as the authority resides with this group. An *IT duopoly* is characterized by two groups, one of IT executives and the other of business executives, coming to agreements in order to make decisions. This is more centralized than the federal form, as the decisions are only made by the two groups, rather than each individual business unit having input. The *feudal* is much less centralized. It is where individual organizational units are responsible for their own decisions. *Federal IT* would aim to balance these through a combination of central IT and IT in the business units. *Anarchy* is a highly decentralized style of governance. It is similar to the feudal archetype, however the size of the units is much smaller. Instead of being an entire business unit, small teams or even individuals are responsible for their own decisions.

2.2.3 Challenges of Progressive Decentralization in Organizational IT

Modern organizational structures show a strong tendency towards de-centralization [36] which results in changes to their management and operation styles. This heavily involves IT and requires major changes in organization processes. This transformation is not a mere question of "flattening" the organization by shifting authorities and decision making power from top to bottom hierarchical levels or from one person to a group. In classic organizations, not only does hierarchy ensure control and coordination, it also manages interdependencies between different subunits of an organization which often makes direct interaction and communication unnecessary [26]. As a result, a challenge related to decentralization and a "weakened hierarchy" is a lack of interaction and communication between organizational subunits. Another major risk of IT decentralization, according to [33], is poor synergy and integration due to a lack of standardization.

Caruso, Rogers and Bazerman [37] highlight the importance of information sharing and coordination for these organizations. In order to succeed at these aspects, they outline three barriers that decentralized organizations need to overcome. The first barrier is intergroup bias; the tendency to treat one's own group better than other groups. The second barrier is group territoriality; the tendency for a group to protect their territory (physical or informational). The third barrier is poor negotiation strategies used by different groups when interacting with one another.

Intergroup bias is direct result of having separate, autonomous groups within an enterprise [37]. The individual groups have a tendency to promote their own group over other groups, especially in situations where they are competing for a resource, such as a portion of the budget. A certain level of competition can be beneficial, however if it leads to hostility or distrust between groups, this can have a detrimental effect on their ability to share information and collaborate. This can prevent the groups from taking advantage of situations where they have to ability to work together for the benefit of everyone.

The second barrier identified by Caruso et al. is group territoriality [37]. Group territoriality is characterized by group members taking action in order to protect their perceived territory. This can include physical territory such as space or tangible resources, as well as intangible territory, such as roles or information. Group territoriality is supported by a group's need to maintain its identity, its reputation of competence and sense of value, and a group's need for a stable home within the organization from which they interact with the rest of it. Group territoriality encourages "a sense of psychological ownership" [37] for a group's members which can enforce the belief that they are the sole responsible party for a role or specific knowledge. This "inward-looking" behavior works against collaboration and information sharing. On the other hand, group territoriality can be beneficial; it can foster a sense of security in its members that "facilitates planning and execution of activities" [37].

The third barrier identified by Caruso et al. in decentralized organizations is related to negotiations between groups, and how these negotiations are often conducted using "poor negotiation strategies" [37]. These poor strategies are the result of three common errors made while negotiating. The first error is a false belief in a "fixed pie" of value that is to be divided when negotiating. This prevents negotiating parties from recognizing situations where they are able to help each other, and therefore increase the size of the figurative pie. The second error is a failure to properly consider the other group's perspective. Understanding the other group's decision process, valuing process, and interests is key to discovering opportunities for helping one another, and the organization as a whole. The

third error is when groups fail to even recognize they are in the process of negotiating. Instead, they see it as a competitive or hostile behavior where, again, they only see a fixed pie that is to be split up. This also prevents groups from taking advantage of opportunities to increase the size of the pie.

2.3 Enterprise Modeling: A "Light-Weight" Alternative to Enterprise Architecture

The practice of EA is just one potential solution to the problems of business-IT alignment. EA is a "heavy-weight" approach in that it aims to be a complete solution. However, other "light-weight" solutions do exist that focus on specific aspects of business-IT alignment and this section will briefly outline one of them: enterprise modeling.

"Enterprise Modeling is the art of externalizing enterprise knowledge which adds value to the enterprise or needs to be shared. It consists in making models of the structure, behavior and organization of the enterprise" [38]. Through modeling, practitioners aim to better understand the current or future organization and function an enterprise. To this end, common enterprise categories of enterprise modeling include goal, process and value modeling.

Goal Modeling

Goal modeling aims to describe the goals of an enterprise, their interrelations, means for achieving these goals, and additional factors that impact them. A specific example of a goal modeling technique is the Business Motivation Model (BMM) [39]. In BMM, means, ends and influencers of an organization are modeled and assessed. Here, the focus is on understanding what an organization wants to achieve (i.e. goals). The relationship between an organizations goals and its means is described, though the specifics of the means are not.

Process Modeling

According to Roshen, "[a] business process is a collection of related, structured activities or tasks that produces a specific product" [40]. Business processes are a complicated matter, and as such, process modeling is used to describe them in a detailed and accurate manner, in order to understand how an organization creates some output. Many different modeling languages exist, for example, Business Process Model and Notation (BPMN) [41], Event-driven Process Chain (EPC) [42, Ch. 6], and UML Activity Diagrams [43]. Processes can exist within an organization (intraorganizational) or they can interact with processes from other organizations (interorganizational). According to Weske [44], "the primary focus of intraorganizational business processes is the streamlining of the internal processes by eliminating activities that do not provide value". Interorganizational processes, on the other hand, aim to specify and streamline interactions with other organizations.

Business Value Modeling

Business value modeling depicts the exchange of value between entities. Examples of value modeling languages are e3 Value [45] and REA [46]. Business value modeling is used to understand what an organization does in order to create value. This allows it to be used as a starting point for the exploration of business ideas, design of processes, or development of systems [47].

Holistic Approaches

A holistic approach to enterprise modeling can also be taken, where a combination of modeling techniques are used to represent an entire enterprise. The relationships between different models are specified, and a method for making the models may also exist. An example of a holistic modeling technique is Enterprise Knowledge Development (EKD) [48, 49], where an organization is modeled using six different models, each with a different focus. EKD also specifies a process for creating the models. A holistic approach to enterprise modeling such as EKD is similar to EA in that it specifies a process (similar to the EA method) and set of models that represent an enterprise (similar to EA description). However it is also quite different from EA in that it does cover how to transform those models into actual enterprise change.

3. Method

3.1 Choice of Research Method

Empirical research "aims at describing, explaining and predicting the world" [11, Ch. 1]. In comparison, design research additionally wants to improve upon the world through the development of artifacts. This thesis project aims to improve EA by proposing an artifact that can extend the support of existing EA frameworks for decentralization. As a result, a design research approach, specifically design science, will be utilized. The remainder of this section seeks to further demonstrate the suitability of design science and outline the specific research strategies and methods chosen.

3.1.1 Design Science and its Relevance to this Thesis Work

Design science is concerned with the development and application of *artifacts* aimed at solving some practical problem [11, 50] in a manner that is of general interest [11, Ch. 1].

In order to be relevant, Design Science must exist in some context. Johannesson and Perjons [11, Ch. 1] define a generic context for design science in terms of people, practices and problems. A practice is a set of related activities performed regularly by people. In the performance of a practice, people encounter practical problems. Two general kinds of problems exist; one where the current state of affairs problematic and the desirable state is neutral, and a second where the current state is neutral and the desirable state is an improvement. The artifacts created through design science can be used by people to solve these practical problems. These concepts are easily related to this thesis work: Enterprise Architecture is a practice with a problem of the second type. The current state of EA can be seen as being neutral; the problems outlined in this thesis are not necessarily ones that EA practitioners are concerned with. However, this thesis argues that existing EA frameworks – each of which can be seen as an artifact composed of smaller artifacts – can be improved by increased support for decentralization through the development of artifacts addressing the issue of decentralization.

According to Johannesson and Perjons [11, Ch. 1], artifacts themselves have an "inner construction", exist in an environment, and have a function. The inner construction refers to the inner components of the artifact and the relations between them. The environment refers to the artifacts practice, the people using it, and anything else in its surroundings that have an effect on it. Lastly, the function of an artifact is the result of using it in its practice. This definition of an artifact also relates well to this thesis work: the inner construction of our artifact (an EA framework for decentralized organizations) can, at a high level, be seen as an EA method, EA description, and EA engine. The relations for these components are outlined in Figure 1.1. The environment of our artifact includes the practice of EA and all affected components of the decentralized organization using it, such as involved stakeholders and implementers. The function of our artifact is, on a high level, to bring the benefits of traditional EA to decentralized organizations (e.g. business-IT alignment).

There exist four different types of artifacts: constructs, models, methods, and instantiations [11, 50]. Enterprise architecture is concerned with the first three of those types: constructs, models and methods.

Constructs are ways to describe some phenomenon. They give a common language for talking about something, but do not make any assertions about reality. For example, the EA description component of an EA framework provides a common taxonomy for the different parts of an organization covered by EA.

Models represent other objects. EA makes use of models, specifically descriptive and prescriptive models. Descriptive models are used to represent a current situation and its challenges, such the "as-is" architecture from the EA description. Prescriptive models represent potential future solutions, such as the "to-be" architecture, also from the EA description.

Methods define "guidelines and processes for how to solve problems and achieve goals" [11, Ch. 1]. The EA method and EA engine are primarily methods, the former to construct the EA description, the latter to ensure its proper use throughout its lifecycle.

This thesis work, being much smaller in scale than an entire EA framework, will focus on the creation of *guidelines* (a method artifact type) for supporting decentralization in EA.

3.1.2 A Design Science Method Framework

Having established the relevance of design science to this thesis project, this thesis will therefore follow the framework for a design science method presented by Johannesson and Perjons in [11, Ch. 4]. This method is composed of five activities with input-output relationships: Explicate Problem, Outline Artifact and Define Requirements, Design and Develop Artifact, and Evaluate Artifact. Each activity has an output which serves as an input to the next activity (e.g. an explicated problem is the input to the Outline Artifact and Define Requirements phase). These activities are carried out in an iterative manner, meaning that the practitioner will move back and forth between them as opposed to working in a sequential manner.

The Explicate Problem activity is concerned with outlining the problem addressed by the research work in detail. To this end, the problem's significance needs to be clearly stated and its underlying causes can be possibly identified and analyzed. The output of this phase an explicated problem.

The Outline Artifact and Define Requirements activity is where the explicated problem is transformed into the requirements for a solution to said problem. The output of this phase is the set of requirements for the artifact.

The Design and Develop Artifact activity is where the artifact itself is built based on the requirements for the artifact. The output of this phase is the artifact itself.

The Demonstrate Artifact activity takes the developed artifact and implements it in either a real or illustrative case in order to demonstrate its viability. The output of this phase is the demonstrated artifact.

The Evaluate Artifact activity is to demonstrate the artifact's fulfillment of the requirements and the degree to which it solves the problem. The output here is an evaluated artifact.

3.1.3 The Role of Research Strategies and Methods in this Design Science Framework

Each of these activities can make use of controls and resources. Controls are the knowledge used to govern an activity [11, Ch. 4], and resources are the knowledge used as a basis for the activity. In this method for design science, controls are the research strategies and research methods used. A research strategy is the overall approach used to

answer a research question [11, Ch. 3], and research methods are the concrete methods used to generate and analyze data.

3.1.4 Choice of Research Strategy

Alternative strategies exist for undertaking research in the field of design science. A number of common strategies will be briefly outlined in order to discuss their suitability for this thesis.

Surveys aim to take a comprehensive look at something by gathering data from a large number of different sources. This data is then analyzed in some manner. Surveys offer a wide view [11, 51], and as such, are not well suited for a depth view of something. This does not fit in with this project which takes an in-depth look at EA frameworks.

Experiments employ a controlled and artificial environment in order to isolate a small number of specific factors to study them in detail. The effects of manipulating variables in the environment needs to be precisely measured [51]. This poses a problem for EA as organizations are highly complex entities where it would be exceptionally difficult to exert precise control and precisely measure the effects. For this reason, experiments are not a suitable strategy for this project.

In action research, the researcher is an active participant in affecting the environment they are researching. Here, the research is done as part of the practice, as opposed to it being a separate activity [51]. This could be a highly effective strategy for this thesis topic as it would allow the researcher to experience the problems of decentralization first-hand. Furthermore, action research is a cyclical process, meaning the researcher could repeatedly try out different solutions and evaluate their effects in order to come to a good solution. This would allow for a researcher in a decentralized organization the flexibility to find a solution that works. Despite this fit to the thesis topic, the practical issue of finding a decentralized organization that is willing to go through this process is a significant one. As a result, action research is not used in this project.

Ethnography is similar to action research in that the researcher becomes a member of the environment being researched. The difference lies in that they are there to integrate themselves into it, rather than affect change [51]. This could be an applicable research strategy for understanding problems from the perspective of stakeholders, however finding a decentralized organization with some sort of EA (or at least an interest in it) is quite the challenge in itself. Additionally, ethnography requires a large time investment in order to integrate adequately into the environment of study, which is not feasible for a Master's project. For these reasons, ethnography is not used in this project.

Case studies take an in depth view of a single instance of the practice where the problem of interest exists. Case studies are ideal when "a researcher wants to investigate an issue in depth and provide an explanation that can cope with the complexity and subtlety of real life situations" [51]. This project is interested in an in depth view of the problem of suitability of EA for decentralized organizations and decentralized organizations are real life entities that are highly complex. Furthermore, in contrast with ethnography and action research, conducting a single case study fits in well with the scope of a Master's project; it is not necessary for the subject organization to invest large amounts of resources into the project and time investment of a case study fits in with a short-term project. For these reasons, this thesis project will employ a case study research strategy.

3.1.5 Choice of Research Methods

Research strategies do not prescribe any concrete ways to generate and analyze data. Specific research methods for data generation and data analysis are needed.

Data generation methods

This thesis employs the use of interviews and document studies for data generation. Document studies are used as a large amount of data on the structure of the organization being studied is available. Documents are a good source of authoritative, objective, and factual data [51], which therefore gives a solid foundation on understanding the studied organization. Interviews were chosen in order to supplement this data with information from stakeholders about the organization. Interviews are suited for gaining insight into complex phenomena, which is supportive of our need for an in-depth view of a complex entity that is an organization. Furthermore, interviews are practical for this project as; a) the organization being studied does not need to invest large amounts of time and b) I have physical access to potential interviewees.

Other common data generation methods are questionnaires and observations. Questionnaires are not particularly suitable for this project as they are most useful when used for specific, straightforward information [51]. This project, on the other hand, is interested in the complexities of an organization. An observation study would require spending time in an organization in order to directly observe its operations. As this thesis is conducted as an individual project, this is not a feasible activity, due to the size and complexity of an organization.

Data analysis methods

After the data has been obtained, it is necessary to analyze it in order to understand the object being studied. Data can be analyzed in either a quantitative or a qualitative manner. Quantitative data analysis is concerned with numeric data, whereas qualitative deals with words and visuals. According to Denscombe [51], some other differences between the approaches are; quantitative research is generally associated with large-scale studies whereas qualitative research is concerned with small-scale studies, and quantitative research is concerned with "specific variables" while qualitative research takes a "holistic perspective". This project follows a qualitative approach because; a) the data being analyzed will composed of words coming from interviews and document studies, b) this is a small-scale study, and c) this project is interested in a holistic perspective on our case study subject.

3.2 Application of Method

This thesis work follows the framework by Johannesson and Perjons [11, Ch. 4] presented above in Section 3.1.2. This section will first elaborate on how the different activities will be accomplished and then outline the overall process.

As suggested in the framework, the IDEF0 notation will be used for visualizing the various activities. In this notation, each activity as an input and output, controls in the form of research strategies and methods, and resources which is the knowledge base for the activity.

Document	Description
Institution's homepage	Contains descriptions of the different organizational areas of the institution as well its organizational structure
Authority delegation documents	These publicly available documents specify authority and delegations of said authority of the institution's organizational units
Rule book	The official rule book of the institution detailing rules and decisions that must be followed by the institution

Table 3.1: Documents used in the document study

3.2.1 Case Study: An Institution of Higher Education in Sweden

This thesis work will use an institution of higher education in Sweden as an illustrative case study. This case was chosen as an example of a decentralized organization with an implicit EA, i.e., there is no formal EA framework used, but as they use IT extensively, some form of implicit architecture must exist. An advantage of this case is that, as a public institution, many official documents are available on its organizational structure, thus making a document study a viable research method. The documents that formed this study are described in Table 3.1.

This institution was chosen as it is an organization that exhibits many of the properties of a decentralized organization (in particular with respect to IT governance). The institution is not a fully decentralized organization, however, as it also has centralized aspects (decision rights, for example, are distributed in a centralized manner). This heterogeneity is actually of interest to this thesis work, as it has manifested itself by resulting in the wasting of financial resources. A full explication of the problem in the case organization (that this thesis work addresses) is included with the results, in Section 4.1.2.

This thesis is not aiming at effecting change in this institution. The focus is instead on: analyzing the state of its EA in order to assess the decentralization support provided in contrast with what is needed; and proposing part of an EA that can provide the needed support.

Four separate interviews are conducted in order to get a holistic view of the institution. The roles of the interviewees are: vice division lead, head of PhD studies, head of undergrad studies, and head of IT. The interviews are conducted in a semi-structured manner, starting with a set of open-ended questions that promote the interviewees to elaborate on their views.

3.2.2 Research Activities

Iterations Between Activities

This research is conducted through two general iterations between the research activities:

Iteration #1 The first iteration focuses on using literature for conducting the research activities. In this iteration, the explicate problem activity, the generate sub-activity of design and develop artifact and a short demonstration were performed.

Iteration #2 The second iteration focuses on the case study in order to supplement the findings from the first iteration and to define the solution artifact. In this iteration, the activities explicate problem, outline artifact and define requirements, the search-and-select sub-activity of design and develop artifact, demonstrate artifact, and evaluate artifact were performed.

Explicate problem

Figure 3.1 outlines the major components of this activity:

Sub-activities Define Precisely, Motivate Problem and Find Root Causes [11, Ch. 5]

Input The initial problem as described in Section 1.2

Resources A literature study on centralization/decentralization in organizational theory, and on the modern EA frameworks TOGAF, Zachman, and FEA. These three frameworks were chosen due to their popularity and extensive available literature.

Controls A case study research strategy that will make use of interviews and a document study. The case is detailed in Section 3.2.1.

Output A fully explicated problem, specifically, the set of specific shortcomings of modern EA frameworks when applied to decentralized organizations determined in the "find root causes" sub-activity.

Iteration #1

The first sub-activity, Define Precisely, is accomplished with the use of the literature reviews on centralization/decentralization in organizations and on EA. A classification for decentralization organizations will be built from the literature review for use in the problem definition.

In the second sub-activity, the problem is motivated through the use a literature review on decentralized organizations. Here, the differences between centralized and decentralized organizations are specified in order to show that there is a problem.

The third sub-activity, find root causes, is accomplished through a literature review. An in-depth analysis of each of the three EA frameworks will done to find specific shortcomings; aspects where the framework provides support for centralized organizations and not decentralized organizations. Aspects that are supportive of decentralization will be presented as well.

Iteration #2

In the first sub-activity, the problem in the case is precisely defined. In the second sub-activity, the problem is motivated through the use of the case study. To this end, a specific issue in the case that arises from their implicit EA and their organizational structure is identified.

The root causes of these issues are then determined in the third sub-activity.

This is accomplished by identifying conflicts between the case organization's architecture principles, and its EA engine and supporting organizational structure.

Outline artifact and define requirements

Figure 3.2 outlines the major components of this activity:

Sub-activities Outline Artifact and Define Requirements [11, Ch. 6]

Iteration #1
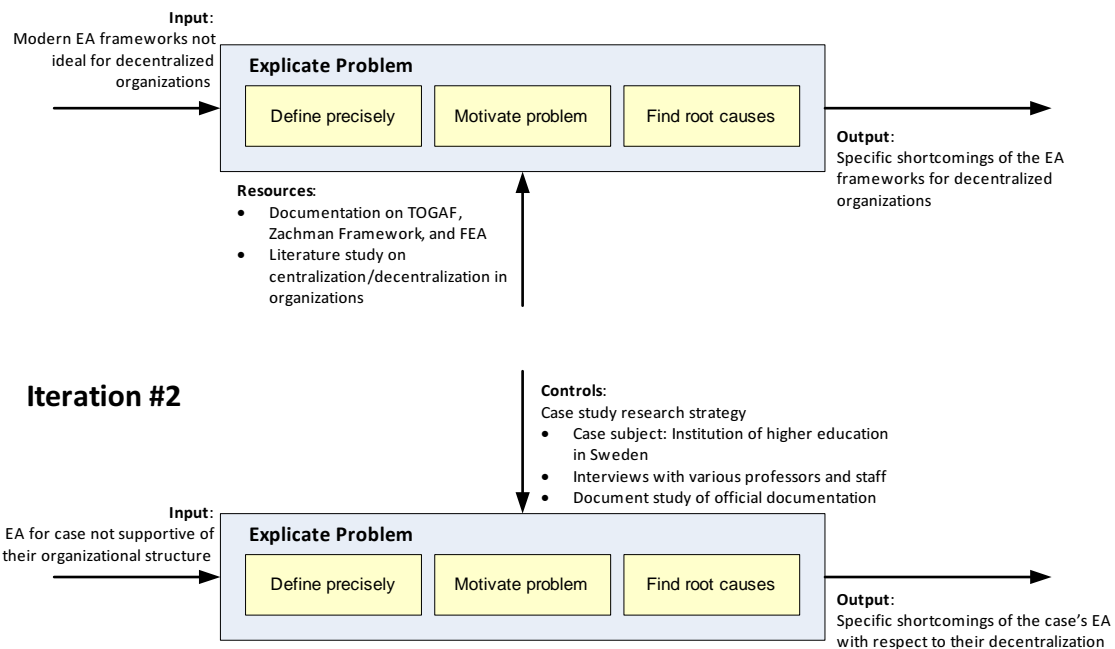
Figure 3.1: Explicate problem activity

Input Set of specific shortcomings of modern EA frameworks when applied to decentralized organizations

Resources Literature study on centralization/decentralization in organizations

Controls Case study research strategy

Output An overview of the artifact, motivation for the selected artifact type (guidelines), and the requirements for the artifact

Iteration #2
In the first sub-activity Outline Artifact, the choice of artifact type, *guidelines*, is explained and the artifact is described on a high level.

In the second sub-activity, Define Requirements, the requirements for the developed artifact are elicited. This is based on the specific shortcomings of the case's EA, the specific shortcomings of EA frameworks, and on the literature study on centralization/decentralization in organizations.

Design and develop artifact

Figure 3.3 outlines the major components of this activity:

Sub-activities Generate and Search and Select [11, Ch. 7]

Input The outlined artifact and requirements for said artifact

Resources Literature study on peer-to-peer architectures

Controls None

Iteration #2

Input: Specific shortcomings of the case's EA with respect to their decentralization

Controls: Case study research strategy
- Case subject: Institution of higher education in Sweden
- Interviews with various professors and staff
- Document study of official documentation

Outline artifact and define requirements

Outline artifact | Define requirements

Output: Outlined artifact and artifact type (guidelines for EA), requirements for the artifact

Resources:
- Literature study on centralization /decentralization in organizations

Figure 3.2: Outline artifact and define requirements activity

Output Guidelines for EA, with a focus on a single part of EA, in decentralized organizations (the solution artifact)

Iteration #1

In this iteration, only the Generate sub-activity is performed. Here, a small number of different peer-to-peer architecture principals that could potentially serve as solution artifacts are outlined using divergent thinking [11, Ch. 7.1]. The basis for these artifacts comes from a literature study on peer-to-peer architectures where principles relevant to EA are identified. Peer-to-peer architectures were chosen because they have offered solutions to decentralization in other domains (e.g. technical) and might therefore be able to provide solutions for the practice of EA.

Iteration #2

In this iteration, one of the outlined solutions is selected and elaborated on to create guidelines for EA in decentralized organizations. These guidelines will focus on one specific area of EA. This selection is based on its applicability to the case, which is an example of a decentralized organization.

Demonstrate artifact

Figure 3.4 outlines the major components of this activity:

Sub-activities Choose or Design Case and Apply Artifact [11, Ch. 8]

Input Guidelines for EA in decentralized organizations (the solution artifact)

Resources Knowledge on the selected case (institution of higher education in Sweden)

Controls A case study research strategy that will make use of interviews and a document study

Output A demonstration of the solution artifact in the case organization

Iteration #1

Here, the current state of the research (problem explication and potential solution outlines) is adapted to papers for submission to EA-related conferences. The output of this is feedback on the research.

Iteration #1
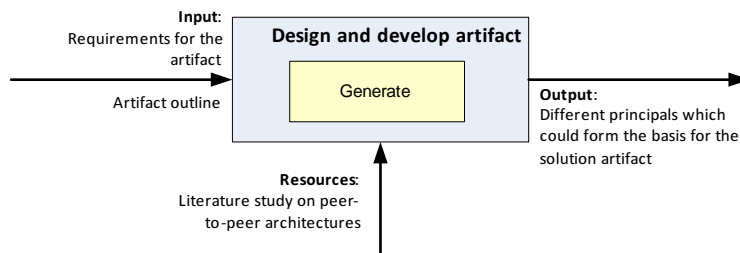
Iteration #2
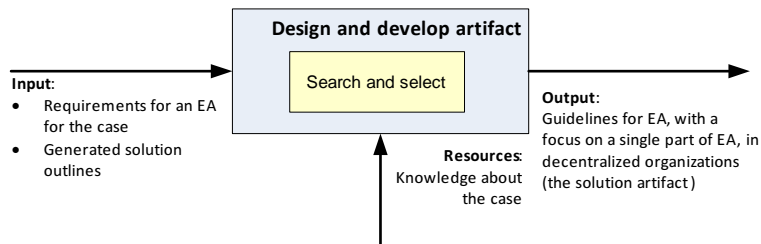
Figure 3.3: Design and develop artifact activity

Iteration #2

For the Choose or Design Case sub-activity, an institution of higher education in Sweden has been selected. Details on the case are described in 3.2.1.

In the Apply Artifact sub-activity, three separate lightweight frameworks are outlined: an "As-Is" framework of the case, a "To-Be" centralized framework based on traditional EA knowledge, and a "To-Be" which is developed using the solution artifact. These frameworks will focus on one specific problem area of the case.

Evaluate artifact

Figure 3.5 outlines the major components of this activity:

Sub-activities Choose Evaluation Strategy and Carry Out Evaluation [11, Ch. 8]

Input Artifact demonstration

Resources Knowledge on the selected case (institution of higher education in Sweden)

Output An evaluated artifact

Iteration #1

This activity is not performed in the first iteration.

Iteration #2

For the Choose Evaluation Strategy sub-activity, an *ex ante* evaluation strategy has been chosen to be used; meaning that "the artifact is evaluated without being used" [11, Ch. 9.1]. Johanneson and Perjons suggest interviews with experts for this sub-activity, however their are no experts available in the case organization, therefore an *"informed argument"* approach is instead being followed. The chosen evaluation strategy (detailed

Iteration #1

Controls:
Conference paper

Input:
Generated solution outlines &
explicated problem

Demonstrate artifact

Apply artifact

Output:
Feedback on the problem and
current direction of the artifact

Iteration #2

Controls:
Case study research strategy
- Interviews with various
  professors and staff
- Document study of official
  documentation

Input:
The solution artifact

Feedback on the problem and
current direction of the artifact

Demonstrate artifact

Choose case:
Institution of higher
education in Sweden

Apply artifact

Output:
A demonstration of the
solution artifact in the
case organization

Resources:
Knowledge about the
selected case

Figure 3.4: Demonstrate artifact activity

Iteration #2

Input:
Artifact demonstration

Evaluate Artifact

Choose Evaluation
Strategy:
Ex Ante

Carry out evaluation

Output:
An ex ante evaluated
artifact

Resources:
Knowledge about the
selected case
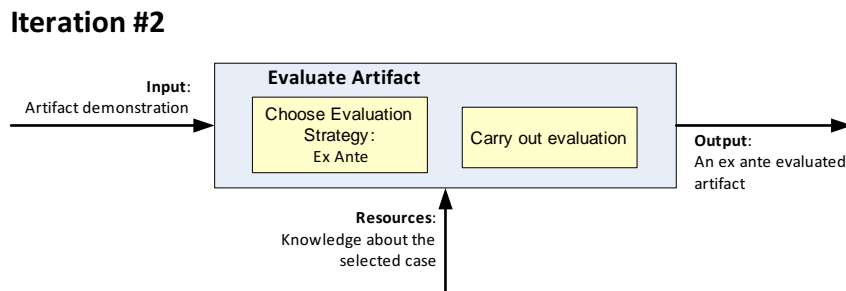
Figure 3.5: Evaluate artifact activity

in Section 4.5.1) will use the artifact's demonstration to show that the artifact can solve
the explicated problem and can fulfil the defined requirements.

In the Carry Out Evaluation sub-activity, the decided upon evaluation strategy is carried
out to create the output for this activity; an evaluated artifact.

3.3 Ethical Considerations

In any research project, the ethical conduct of the researcher is critical to not only the
validity of the project, but to the research area a whole. As stated by Denscombe [51]:
"this expectation stems from the belief that the public should be protected from
researchers who might be tempted to use any means available to advance the state of
knowledge on a given topic." In this thesis, this is primarily applicable in two areas:

First, it is critical that I, as the researcher, do not let my personal beliefs on the current
state of decentralization support in EA effect the collection, interpretation and analysis of

the results of this thesis. In practice, it is not possible to completely remove all bias, but it is key that I maintain as neutral of a position as possible. For this reason, it is important that this thesis work identifies areas where EA supports decentralization, and not only areas where support is lacking.

The second area where ethics were critical were in my interactions with the case organization. While no implementation was performed, it was still important that the wishes of the case organization are respected. Their wish is that they remain anonymous, and for this reason, their identity has been withheld from being published. Secondly, interviews are used as a means of data collection, and therefore, it is important that the beliefs of the interviewers are not pushed upon the interviewees. To avoid this, the interviewers will only guide the direction of the interview by asking questions, but will not provide any feedback about how they feel about the responses.

4. Results

The results are presented in a manner that follows the application of the design science approach chosen for this thesis work. Each section corresponds to a design science activity (Explicate Problem, Outline Artifact and Define Requirements, Design and Develop Artifact, Demonstrate Artifact, and Evaluate Artifact). Each section is further divided into iterations, corresponding to the iterations outlined in Section 3.2.2 and then into sub-activities, corresponding to the design-science sub-activities that were performed.

4.1 Explicate Problem

4.1.1 Iteration 1

Define Precisely

Classification of Organizational Structures

To precisely define our problem, we first need to define a taxonomy of organizational structures in order give a common way of describing these structures. To this end, we agree with Rockart, Earl and Ross [33] who describe a continuum of IT governance styles ranging from centralized to decentralized, with federalism in the middle. Many organizations today tend to combine both centralization and decentralization in order to obtain the advantages of both styles: global integration and efficiency due to centralized management in some key areas and agility and high quality of local customer services due to decentralized decision making in others.

For the purpose of this thesis work, three types of organizational structure in IT are considered along a centralization continuum: *Centralized IT*, where all IT related decisions are made in a centralized manner by the top-level executives, *Decentralized IT*, where each organizational subunit manages its IT in completely autonomous and independent manner, and *Federal IT* that can be seen as a combination of central IT management and IT management in the subunits. Here a primary task would be to maintain standards for the entire enterprise while supporting flexibility on the subunit level. The business units would still have ownership of many of their own systems, allowing them to implement them as they deem best.

A mapping of the organizational forms presented in Section 2.2 to the continuum was developed as part of this thesis work (presented in Figure 4.1), organizing them from highly centralized (e.g. bureaucratic) to decentralized (e.g. virtual organizations).

Role of EA

As detailed in Section 2.1, Enterprise Architecture is a discipline that allows an organization to construct and evolve its IT according to its needs. It provides a methodology and sets up a framework for assessing the current state of IT (architecture As-Is), for agreeing upon and communicating its future state (architecture To-Be), for planning, and for carrying out this transformation. By providing this framework, the modern EA frameworks of TOGAF, Zachman and FEA aim to solve the problem of business-IT alignment from the ground up through proper design.
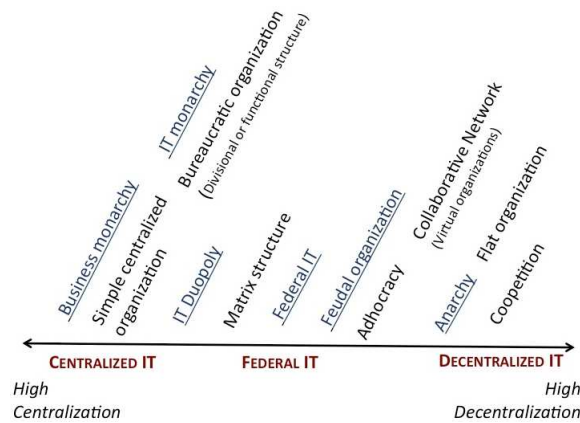
Figure 4.1: Organizational Taxonomy: A Continuum From Centralized to Decentralized

The Problem

Many modern organizations are adopting significantly different organizational structures in comparison with traditional, centralized organizations. This is often characterized by a shift towards the High Decentralization end of the organizational taxonomy (Figure 4.1) and increasing demand in flexibility and agility of their IT. Consequently, there is a need to support this difference in structure, communication patterns, and governance that is adopted by these organizations.

The problem is that the EA frameworks of TOGAF, Zachman and FEA are primarily supportive of organizations with an structural form on the High Centralization end of the centralization continuum (Figure 4.1). This is a problem for organizations on the High Decentralization end of the spectrum, who will likely encounter issues if they implement EA as it is currently described in TOGAF, Zachman, and FEA. Therefore, the addition of specific guidelines to these frameworks that are supportive of decentralization would improve their support of decentralized organizations.

Motivate problem

The problem of EA frameworks not being ideally suited for organizations on the High Decentralization end of the spectrum is important because: 1) many organizations adopt a decentralized structure [5, 52], and 2) like centralized organizations, decentralized organizations can potentially benefit from the practice of EA.

Organizations on the High Centralization end of the continuum fail to adapt to dynamic environments due to their inertia in decision making and lack of agility [2, 5]. As a result, some organizations are moving towards High Decentralization, with organizational structures such as Collaborative Networks [31] and Flat, where organizational subunits and individuals are being given an increasing amount of autonomy and control. Decentralized structures support transparent or dynamically changing boundaries, agile processes, interactions aligned in real-time with changing business conditions, virtual collaborations; all of which are technology-enabled capabilities [5, 28].

Decentralization means a significant change from the traditional management and operation styles of an organization and requires major changes in organizational processes. It transforms the role of authority and makes relationships inside and between different subunits much more complex. Planning and governance in different functional areas, including IT, is no longer centrally ensured. As a consequence, collaboration and

36

information sharing between subunits gain extreme importance. This is evident in the challenges of decentralized organizations outlined in [37].

While technology serves as an important catalyst for organizational transformations, it is important to utilize the right IT resources in a manner that is supportive of the organization. To accomplish this in decentralized organizations, novel EA processes, principles and concepts are needed to both handle the IT resources and to foster business/ICT co-evolution in decentralized environments. The de-facto EA frameworks rely on organizational properties that are becoming obsolete with progressive decentralization. Due to this, implementation of these frameworks in decentralized organization becomes difficult and inefficient and the role of EA as a driver for IT transformations is becoming compromised. In order to deal with progressive decentralization, some changes or additions to these EA frameworks are necessary in order to improve their support for decentralization.

Find root causes

The root cause of the discrepancy between current EA frameworks and decentralization lies in the fact that centralized and decentralized organizations have significantly different properties that are not always fully supported by EA. This section outlines these properties and specific areas of TOGAF, Zachman, and FEA that are supportive and not supportive of them.

Properties that differ between centralized and decentralized organizations

A number of key properties of organizations and how they can differ between centralized and decentralized organizations have been identified. These properties are detailed in Table 4.1.

TOGAF: Concepts supporting centralized organizations

EA Method and EA Engine

TOGAF outlines a formal approach to architecture governance which involves the setting up of an Architecture Board "to oversee the implementation of the [architecture] strategy" [1, Ch. 47]. This board has an important role in Architecture Governance, such as "[p]roviding the basis for all decision-making with regard to the architectures" [1, Ch. 47] and enforcing architecture compliance.

Architecture board concept suits well for the organization with strong centralization in IT (Centralized IT to Federal IT in Fig. 4.1. Having a single entity responsible for high-level decision making is an aspect of vertical coordination and as such, fits in with the concept of a Centralized IT organization. TOGAF does suggest that the board has enterprise-wide representation [1, Ch. 47] which may support some level of decentralization, however it suggests the representation comes in the form of "senior managers"; a concept which is again characteristic of vertical coordination.

Throughout TOGAF, references are made to the existence of a bureaucratic or hierarchical centralized structure in place:

For example, an important part of the preliminary phase is to set up a *formal governance framework* for all architectural material, a concept that is related to the rigid forms of traditional organizational structure.

Another example: after the completion of "Phase A: Architecture Vision", TOGAF requires approval of the current vision of the architecture. This requirement of approval

Property	Centralized	Decentralized
Geographical dispersion [25]	Single location	Geographically distributed with a reliance on IS to work together [28]
Coordination: authority, decision rights, standards and regulations	*Vertical coordination*: decision rights are strictly defined and work their way down from the top [2, 35]; strict governance and control by upper management [2, 28]; rigid structuring of accountability, roles and responsibilities [28]; standard methods and procedures [23]; homogeneous goals set by high-level authorities [29]	*Lateral coordination*: authority and decision-making rights are pushed down to the level of groups, units or even individuals [2, 24, 31, 35]; individuals can define their own roles and responsibilities [30]; heterogeneous goals, but individual entities in the organization are collaboratively working towards some common or complementing ones [31]
Communication patterns	Communication patterns follow the hierarchy [2, 28]; direct interactions and communications are often unnecessary [26];	Informal communication lines [2]; flexible, constantly changing communication lines [27]; fluid, project oriented teams. [28]

Table 4.1: Organizational properties identified in the literature study

assumes the existence of someone with a higher level of decision-making authority to give approval.

A third example is an entire set of architectures at the strategic level of the Architecture Landscape which is meant for the "executive level" [1, Ch. 20].

EA Description

TOGAF suggests the development of architecture principles that "...define the underlying general rules and guidelines for the use and deployment of all IT resources and assets across the enterprise" [1, Ch. 23]. Having a set of principles that is applied to an entire organization is characteristic of vertical coordination and therefore supportive of centralization.

TOGAF includes the concept of an Architecture Repository, which is to hold the entirety of the Architecture Landscape in addition to other architecture-related information. The idea of a single place to store all information is highly supportive of centralization.

TOGAF: Concepts supporting decentralized organizations

EA Method and EA Engine

TOGAF primarily supports some level of lateral coordination and decentralization through the concept of *partitions*. It suggests dividing the Architecture Landscape into separate parts in order to support multiple architecture teams working concurrently and conflicting architectures in different organizational units. This enables "federated architectures — independently developed, maintained, and managed architectures that are subsequently integrated within an integration framework" [1, Ch. 40.3].

Furthermore, "[f]ederated architectures typically are used in governments and conglomerates, where the separate organizational units need separate architectures" [1, Ch. 40.3]. This supports the idea of different organizational units developing their own individual architectures. The mechanism for integrating the individual architectures under the roof of the corporate architecture is not explicit.

TOGAF additionally indirectly supports decentralization through the suggestion that the entire TOGAF process be *tailored to fit the needs of the enterprise*. This is done in the preliminary phase of the ADM. This allows TOGAF to support any kind of enterprise, however, the guidelines provided for this are minimal.

Zachman: Concepts supporting centralized organizations

EA Description

The Zachman Framework aims to model a complete enterprise in a single, "periodic table of elements" [8]. It attempts to break down an enterprise into a matrix of 36 elements, with alignment and composite integration relations defined between these elements.

The perspectives of Zachman Framework line up with a bureaucratic organizational structure: the defined views (from executive to user) constitute an explicit organizational hierarchy. Clear separation between domains make this framework suitable for matrix organizations as well.

The lack of flexibility in definition of domains and views and the requirement to fill in the matrix - is perhaps the Zachman Frameworks main shortcoming with respect to decentralization. A primary aspect of decentralized organizations is their high level of flexibility. For a decentralized organization where both roles and domains are not

uniformly defined (implicit) for subunits, the use of the Zachman Framework becomes difficult if at all possible.

EA Method and EA Engine

Providing a schema for organizing architectural artifacts of an enterprise, the Zachman Framework does not imply any particular method for collecting these artifacts (what we call EA Method in Fig. 1.1). Neither is suggests the set of structures that we call EA Engine.

Therefore, tailoring and implementation of Zachman framework for a concrete organizational structure depends on experience of the EA (consultancy) team.

To summarize, the Zachman Framework provides a detailed taxonomy of EA artifacts that supports a hierarchical view on the organization. The application of this framework in decentralized (flat, adhocracy) organizations remains unclear.

FEA: Concepts supporting centralized organizations

EA Description

Through the use of a common set of *reference models*, FEA prescribes standards that are to be followed throughout the organization. This vertical coordination limits the flexibility that the individual organizational units have and makes this framework suitable for bureaucratic organizations with a high level of standardization in its processes.

In FEA, however, individual organizational units have the freedom to develop their own architecture as long as it fits in to the set standards. This lateral coordination supports some level of decentralization and is suitable for organizations with federal structure, where individual units have input into decisions.

EA Method and EA Engine

Segment architecture development is defined by FEA as a collaborative approach conducted by an integrated project team (IPT) comprising business subject matter experts, enterprise architects and technical subject matter experts. FEA defines a set of segment architecture stakeholders and their roles (Table 2-2 in the document [4]) whose "commitment must be attained to support each step in this [development] process." [4]. For example, the role of senior management is defined to set the agency strategic goals; chief architect and EA team are appointed to supervise the architecture development process, coordinate the activities of other stakeholders and communicate and share the information between segments when needed; IPT activities and meetings are coordinated and managed by a Program Manager. The Program Manager should monitor progress, evaluate segment architecture completion and demonstrate results. These roles naturally line up with the centralized to federal organization of IT (Fig.4.1).

The mechanisms for enforcing standards and compliance, cross agency collaboration, and integrating the segment architectures under the roof of the corporate architecture is assured by specific governance and management processes which, while implying different stakeholders, are based on vertical coordination.

All steps of segment architecture development involve/supervised by the Program manager and/or chief architect or Capital Planning and Investment Control (CPIC) lead, pointing on centralized management and budgeting.

Transition strategy is defined for the agency level though it is assessed on the global level. Governance-wide collaboration and reuse based on standards is outlined by FEA as an important part of RA transition strategy.

FEA: Concepts supporting decentralized organizations

EA Description

The resulting segment architecture is positioned by FEA as a shared vision for business and IT transformation within a core mission area or common service. Each segment can have its own architecture that responds to its business needs.

EA Method and EA Engine

The development of *segment architectures* is described as a collaborative process between EA architects and other stakeholders. The accent is placed on the "reconciliation" of the segment architecture with an agency architecture and cross-agency initiative, emphasizing the importance of cross-agency collaboration, common opportunities and initiatives.

Architectural analysis and architectural definition steps of segment architecture development involve business owners at the agency level who define business and information management requirements for the segment. This allows to ensure the local, agency-level interests within a corporation.

FEA is targeting the groups of independent federal agencies with an objective to increase their interoperability and quality of service they are offering for citizens. Among three EA frameworks considered in our study, FEA is the only one recognizing the need of inter- and intra-agency cooperation and communication. Nevertheless, many of the concepts on which the EA method and EA engine of FEA are grounded remain strongly centralized. Again, this supports our initial claim.

4.1.2 Iteration 2

Define Precisely

The case organization has many of the properties of a decentralized organization and therefore needs an EA supportive of this decentralization. Currently, this is not the case as their implicit EA maintains some highly centralized components and is therefore not fully supportive of this decentralization.

Motivate problem

This mismatch between centralized aspects and decentralized aspects has resulted in wasted financial resources. For example, consider a situation outlined in the interview with the vice-head of the department which concerned the acquisition of a software system with the objective of integrated facility management across departments. The departments were not involved in the decision making process and a subset of them consequently refused to shut down their local systems and switch to the global one. As a consequence, the strategic initiative for integration failed; the departments were able to protect their interests (local systems tailored for their needs), but were still charged for the acquired system they never used. This example demonstrates one of the problems caused when there is a mismatch between architecture principles (tendency towards integration), architecture engine (the process of prioritizing, evaluating and eventually deciding on the global system to adopt) and organizational structure.

EA component:	Existing support for centralized organizations	Existing support for decentralized organizations	Applicable P2P principles for a solution
EA Method:	Approval process based on hierarchy; architecture development is coordinated, supervised and evaluated by well-defined roles in a company (e.g. senior managers define strategic goals); EA teams coordinate architectural work and communicate results; results are controlled and evaluated centrally - by program manager)	Federated architectures; possibility to adapt ADM for a specific organization; architecture development process involves multiple stakeholders	peer production principles for creation and evaluation of EA artifacts; P2P trust management replacing approval mechanism
EA Description:	Strategic level architectures; hierarchy of architecture principles; a common set of reference models; hierarchical organization of EA artifacts with explicitly defined roles and domains (Zachman)	Architecture partitions; architecture reference models; segment architecture; the concept of "shared vision"	User-driven content submission and change management of the content (i.e. the structure is defined by the users)
EA Engine:	Architecture board; vertically coordinated governance framework; common set of principles for entire organization (i.e global commitment is taken for granted); centrally managed architecture repository	integration of various (segment) architectures is assured by (centralized) management and governance	Peer production for relevance/accreditation (e.g. decision making in budgeting, strategy, opportunity evaluation, solution evaluation); user-driven content submission and change management of the content; P2P trust management

Table 4.2: Existing and Prospective support of Progressive Decentralization by EA frameworks

Find root causes

The root causes of this mismatch will be highlighted by looking for conflicts between the university's architecture principles, and its EA engine and supporting organizational structure.

Two architecture principles the university seems to operate under came to light during the course of the interviews and document study:

1. Decision making rights are pushed down as close to the operational level as possible[1].

2. Integrate systems across the university[2,3].

The following characteristics of the university's EA engine and supporting organizational structure were uncovered:

- The allocation of decision rights is done in a centralized manner. All the rights come from the government and are distributed down through the various levels of the university[2,1]. The top level, the government, begins with all decision rights. The government then delegates a subset (in this case, almost all of them) of them to the next level, the University Board and the Senior Management Team. This continues with each level keeping some decision rights that were allocated to them and passing on the rest until it reaches the bottom level; that of the staff and teachers/professors of the University. This is shown in Figure 4.2, with the green arrows depicting the path that the decision rights allocation follows.

- The university maintains centralized control over budgeting[2,4].

- Strategic planning is centralized; the university board sets the overall strategy for the university and the departments set their own strategy which must be approved by the university[2,1].

- IT is managed is separately at the university and department levels. IT at the department is completely decentralized from the university-level IT, i.e. the university IT has no control over the department IT [3].

- Cooperation and coordination between the department IT and the rest of the university is completely voluntary and is undergone for mutual benefit [3].

- The department IT controls its own projects, however approval from the department head is needed for expensive ones [3,2].

- There are no metrics used for measuring IT project success [3,2].

- Centres (separate groups within the department) are responsible for their own IT, though they may use the central IT systems as well[2].

---

[1]From the document study
[2]From the interview with the department vice-head
[3]From the interview with the head of IT
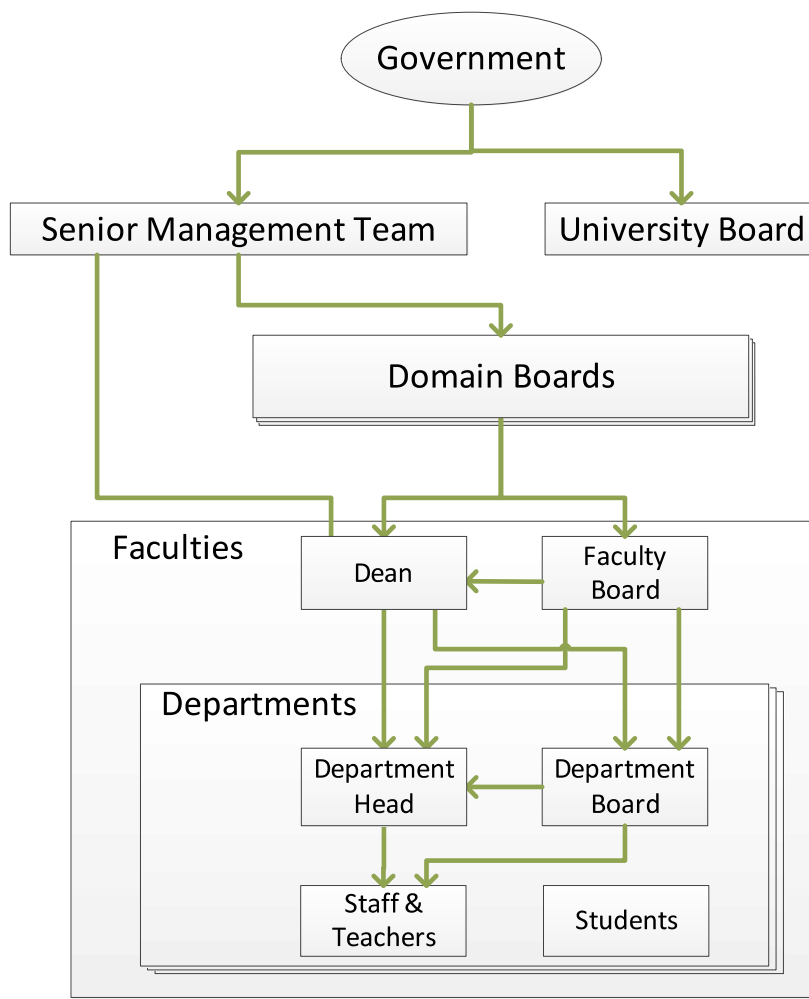[4]From the interview with the head of PhD studies

Figure 4.2: Allocation of decision rights in the university

These principles and characteristics include highly centralized as well as highly decentralized aspects. From the EA engine, strategic planning, allocation of decision rights, and budgeting are centralized, which support the principle of integrated systems (which is also centralized). However, in practice, decision rights are actually pushed down to the operational level (the first architecture principle) which results in completely decentralized IT management: the university IT and the departmental IT are completely separate with the university IT exerting no control of the department. This is in conflict with the principal of integration as the university is not able to enforce integration, meaning, the department can decide to go against integration if it is at conflict with their own interests.

4.2 Outline Artifact and Define Requirements

4.2.1 Iteration 2

Outline Artifact

A key issue identified in the case is with decision making, where a mismatch exists between their integration- and centralization-focused architecture and an organizational structure with some highly decentralized aspects. This mismatch leads to problems in the ongoing success of the university's current architecture – which is a problem addressed by the EA engine. Furthermore, as this issue lies in how decisions are made and enforced (i.e. the decision to have university-wide integration through use of a common system that cannot be enforced in practice), guidelines for a governance framework which resolves these mismatches shall be developed.

As identified in Section 4.1, an important property of a decentralized business environment that needs to be supported by EA is horizontal coordination. However, current EA frameworks primarily support vertical coordination in their governance styles, as identified in Section 4.1 and Table 4.2. Consequently, a different approach to EA governance is necessary for decentralized environments.

This thesis project will create an *informal method artifact* [11, Ch. 2.4] in the form of a set of *guidelines* to address this issue of governance in EA.

Define Requirements

The requirements for the artifact are outlined in Table 4.3.

4.3 Design and Develop Artifact

4.3.1 Iteration 1

Generate

The purpose of this "Generate" sub-section is to generate alternative principals that could be used for a solution artifact. One of these alternative principals are used in next sub-section, "Search and Select", in order to build the fully developed solution artifact.

The challenge of decentralization is not a new one; other efforts have been able to address their view on it with success. The specifics of the challenge varies between domains, however there may exist general principles that can be taken and applied to EA.

One such effort is peer-to-peer architecture. According to Saroiu, Gummadi and Gribble, peer-to-peer systems "...typically lack dedicated, centralized infrastructure,

Requirement	Source
1 The artifact shall support lateral coordination	
1.1 The artifact shall support decentralized authority structures	[2, 24, 31, 35]
1.3 The artifact shall support heterogeneous goals	[31]
2 The artifact shall support governance activities	
2.1 The artifact shall address architecture interoperability and integration issues	The primary purpose of governance in FEA [4, Sec. 2] and TOGAF [1, Ch. 50] is to ensure architecture components work well with one another for meeting an organization's goals

Table 4.3: Requirements for the solution artifact

but rather depend on the voluntary participation of peers to contribute resources out of which the infrastructure is constructed. Membership in a peer-to-peer system is ad-hoc and dynamic..." [53].

We argue that peer-to-peer is a relevant concept to decentralization in EA for two reasons. First, individuals in highly decentralized organization are able to contribute to the enterprise in a manner that is completely up to them. This is similar to peers in a peer-to-peer system, where the peers participate in a completely voluntary manner. Second, the challenge that peer-to-peer systems overcome is similar to the main challenge faced by decentralized organizations. Saroiu et al. state that the challenge of peer-to-peer systems is to "to figure out a mechanism and architecture for organizing the peers in such a way so that they can cooperate to provide a useful service to the community of users" [53]. This is similar to the main challenge facing decentralized organizations–a lack of interaction and communication, or in other words, cooperation–which was identified in Section 2.2.3.

With EA being a potential solution to this challenge of decentralization in organizations and the parallels between the domains of peer-to-peer systems and decentralized organizations, we propose that peer-to-peer may be a potential source of principles that could form the basis for evolving current centralization-focused EA frameworks into ones that are supportive of decentralization. This section outlines solutions based on relevant principles from peer-to-peer that have been generated through brainstorming.

Peer production

Benkler defines peer production as "...production systems that depend on individual action that is self-selected and decentralized, rather than hierarchically assigned" [54]. Here, individuals act according to their own will rather than being directed by a central figure. Peer production works on the idea of the individuals willingly coordinating with one another by expressing their own views while understanding the views of others.

Peer production takes many different forms. One example are user-driven media sites such as Reddit[5] and Slashdot[6], which follow a peer-production model for producing "relevance/accreditation" [54] on user-submitted content. On these sites, the users have the ability to vote on the submitted content in order to decide on the content's relevance or credibility. Another example of relevance production are crowdfunding sites such as Kickstarter[7] where individuals decide on the funding of user-submitted projects by giving their own money. Peer production is also used to produce content, such as in the case of Wikipedia[8], an online encyclopedia which provides a platform for user-driven content submission and change management of that content.

If we view enterprises as being composed of peers (a peer could be individual or an organizational unit), the idea of peer production becomes useful for EA. For example, the EA Engine of TOGAF relies on an Architecture Board responsible high-level decisions and governance. Instead of a central board responsible for making decisions, a model based on the principle of peer production for relevance/accreditation could be used instead. This would better support decentralization as decision making would then be distributed amongst the peers that make the organization.

Trust management in peer-to-peer

Due to the fact that peers in peer-to-peer systems are able to operate in a completely independent manner, there exists the problem of knowing whether or not the contribution made by a peer is trustworthy or not. Consequently, some researchers have proposed various methods for determining trust in a peer-to-peer environment.

For example, Aberer and Despotovic [55] have proposed determining whether a peer is trustworthy or not based on a peers history of interactions with other peers in the system. This assessment is performed by the individual peers, and as such, is appropriate for a peer-to-peer environment.

TOGAF employs the idea of an approval process grounded on the presence of centralized authority. This is to ensure that the presented architectural material is in fact valid for the enterprise. In a decentralized environment, this central authority is not likely to exist. Peer-to-peer trust management may offer a solution here. Instead of being give an explicit stamp of approval, the acceptance of a peer's contribution to EA by other peers can be based on a peer's level of trustworthiness.

4.3.2   Iteration 2

Search and Select

As the problem outlined in "Iteration 2" Section 4.1 relates primarily to the decision making aspect of the university's EA engine, **the principle of peer production – which relates to the governance of a decentralized group of people striving towards a common goal – will be used to create the solution artifact**. The principle of trust management in peer-to-peer would be useful in determining whether some produced content (i.e. an EA artifact) is of sufficient quality to be included in the overall architecture, but is not as applicable to the problem of a mismatch between decision-making structures.

---

[5] `www.reddit.com`

[6] `www.slashdot.org`

[7] `www.kickstarter.com`

[8] `www.wikipedia.org`

As highlighted in table 4.2, EA frameworks often assume vertical coordination, for example the Architecture Board of TOGAF. Here, some central authority is responsible for the overall decision making with respect to the architecture. This thesis instead proposes a solution artifact that can provide support for an EA that supports the horizontal coordination that is characteristic of decentralized organizations.

The Solution Artifact

The solution artifact is composed of three peer production based guidelines aimed at providing increased support for decentralization in EA:

1. Wilful coordination

Instead of strict, formal compliance measure, operate under the principle that the architecture requires wilful coordination by individual entities. This is based on the idea from peer production that individuals willingly coordinate with one another for the purpose of mutual benefit.

2. Decentralized authority structure

Allow for operational departments to make decisions for themselves about their relevant areas, thus granting them freedom to do as they see best. With respect to IT, for example, an individual business unit should have the authority to decide which systems they should develop themselves, and when they should collaborate with the rest of the organization.

3. Peer decision making

Decision making should be distributed to the affected individuals as opposed to residing with an top-level entity. This can be done by giving everyone the right to vote on a decision. Since it is however not feasible to vote on all decisions, such voting should be reserved more for major decisions.

4.4 Demonstrate Artifact

4.4.1 Iteration 1

The ideas presented in this thesis work were adapted into two short papers that were submitted to two conferences, PoEM[9] 2013 and the TEAR workshop at IEEE EDOC[10] 2013: [56] and [57]. The main feedback from these conferences agreed with the problem explication. There was an general agreement that the difference in communication and decision making management between centralized and decentralized organizations required some new governance models in the field of EA.

4.4.2 Iteration 2

In order to apply peer production to the case, it is important to understand the current or "as-is" situation with the case. It is also important to consider a multiple approaches to solving governance issues present in the case organization in order to have a wider perspective on how to best solve the issues. For these reasons, multiple governance frameworks have been developed.

The three guidelines which compose the solution artifact are demonstrated through the development of three governance frameworks: an "as-is" governance framework

---

[9]http://poem2013.rtu.lv
[10]http://planet-sl.org/edoc2013/

reflecting the case organization's current state (tables 4.4 and 4.5); a "to-be" centralized governance framework using traditional EA concepts (tables 4.6 and 4.7); and a "to-be" decentralized governance framework where the three guidelines are used for its development (tables 4.8 and 4.9). Both of the to-be frameworks are aimed at addressing issues in decision making identified in the case organization.

As-Is Governance Framework

Table 4.4: As-Is Governance Framework: General Governance

Governance Aspect	Property (From Table 4.1)	Centralization	Description
Allocation of decision rights	Coordination	Centralized	Decision rights are granted by the Swedish government to the University Board and Vice-Chancellor. From here, they are either kept or delegated to the lower levels as depicted in Figure 4.2[1,2].
Decision rights in practice	Coordination	Decentralized	The university operates under the principle that decision rights are pushed down as close to the operational level as possible[1,2].
University board	Coordination	Centralized	Top-level board responsible for university-wide strategic direction setting and overall control economic control[1].
Faculty board	Coordination	Centralized	Faculty-level board responsible for faculty-wide strategic direction setting and economic control[1].
Department board	Coordination	Centralized	Department-level board responsible for department-wide strategic direction setting and economic control[1].
Budgeting	Coordination	Centralized	Faculty sets funding for department, and the department board controls allocation within the department. If the department is under, leftover funds goes to other departments who go over. If the department is over, they are not guaranteed to be covered for it[2,1].

Table 4.4 – continued from previous page

Governance Aspect	Property (From Table 4.1)	Centralization	Description
Performance measurements	Coordination	Decentralized	The university does not employ formal centralized performance measurements for its projects[2,3].
Advisory group	Communication patterns	Mixed	An advisory group composed of members from all aspects of a department give suggestions to the department head[2,1]. This group does not have any decision making power, however, meaning they are not fully decentralized.
Department operating principles	Coordination	Centralized	The department sets specific operating principles yearly that need to be approved by the Faculty[2].
Department strategy	Coordination	Centralized	The department sets general strategy and vision set every 3 years and needs to be approved by the Faculty[2].

Table 4.5: As-is Governance Framework: Information Technology

Governance Aspect	Property (From Table 4.1)	Centralization	Description
Authority structure	Coordination	Decentralized	The department and the university have separate IT and the departmental IT does not report to the university[2,3].
IT adoption (department IT)	Coordination	Decentralized	Department IT does not dictate all IT used in the department, research projects and centers, for example, can develop and use their own IT systems should they desire [4,3].
Approval (department IT)	Coordination	Mixed	IT projects are run by independently by IT, though they sometimes need approval from the department if they are expensive[3].

Table 4.5 – continued from previous page

Governance Aspect	Property (From Table 4.1)	Centralization	Description
IT collaboration	Coordination	Decentralized	Any decision to cooperate with other departments or with the university IT is made by the departmental IT itself and is based on the cooperation resulting in mutual benefit[3].
Management of essential central systems	Coordination	Centralized	Essential central systems (eg. administrative systems such as HR) for the whole university are controlled by the university board. The department is required to pay for and use or interface with these systems. [3].
Management of non-essential central systems	Coordination	Mixed	The department is required to pay for these central IT systems but is not required to use the.m[3].

Centralized Governance Framework

Table 4.6: Centralized Governance Framework: General Governance

Governance Aspect	Property (From Table 4.1)	Centralization	Description
Allocation of decision rights	Coordination	Centralized	Unchanged from As-Is.
Decision rights in practice	*Coordination*	*Centralized*	*A highly specified and controlled set of decision rights are pushed down to the operational level. For example, this is similar to how the Zachman Framework and FEA strictly define roles, or how TOGAF suggests an Architecture Board which maintains decision making authority.*
University board	Coordination	Centralized	Unchanged from As-Is.

Table 4.6 – continued from previous page

Governance Aspect	Property (From Table 4.1)	Centralization	Description
Faculty board	Coordination	Centralized	Unchanged from As-Is.
Department board	Coordination	Centralized	Unchanged from As-Is.
Budgeting	Coordination	Centralized	Unchanged from As-Is.
Performance measurements	Coordination	Decentralized	Unchanged from As-Is.
Advisory group	*Communication patterns*	*Centralized*	*No advisory group. The department head makes all decisions based on the reports of the managers that directly report to him/her.*
Department operating principles	Coordination	Centralized	Unchanged from As-Is.
Department strategy	Coordination	Centralized	Unchanged from As-Is.

Table 4.7: Centralized Governance Framework: Information Technology

Governance Aspect	Property (From Table 4.1)	Centralization	Description
Authority structure	*Coordination*	*Centralized*	*The department IT is a subordinate entity to the Central IT.*
IT adoption (department IT)	*Coordination*	*Centralized*	*All IT systems used in the department are controlled by the department's IT department. This is similar to the theme of strictly defined roles present in EA.*
Approval (department IT)	*Coordination*	*Centralized*	*Any IT projects need to be approved by the Central IT, following the concept of an approval process based on hierarchy present in EA.*
IT collaboration	*Coordination*	*Decentralized*	*All cooperation is controlled and managed by the Central IT.*

Table 4.7 – continued from previous page

Governance Aspect	Property (From Table 4.1)	Centralization	Description
Management of essential central systems	Coordination	Centralized	Unchanged from As-Is.
Management of non-essential central systems	*Coordination*	*Centralized*	*The university decides whether or not the department is required to pay for and use central IT systems, as it is in a hierarchical organization where the higher levels in the hierarchy dictate how the lower levels should operate.*

Peer Production Based Governance Framework

Table 4.8: Peer Production Based Governance Framework: General Governance

Governance Aspect	Property (From Table 4.1)	Centralization	Description
Allocation of decision rights	Coordination	Centralized	Unchanged from As-Is.
Decision rights in practice	Coordination	Decentralized	Unchanged from As-Is.
University board	Coordination	Centralized	Unchanged from As-Is.
Faculty board	Coordination	Centralized	Unchanged from As-Is.
Department board	*Coordination*	*Centralized*	*Department-level board responsible for department-wide budgeting. This follows the guidelines of "decentralized authority structure" and "wilful coordination" by removing the centralized strategic direction setting in the department.*

Table 4.8 – continued from previous page

Governance Aspect	Property (From Table 4.1)	Centralization	Description
Budgeting	*Coordination*	*Mixed*	*Faculty sets funding for department, and the department board controls allocation within the department. The department has complete control over their allocated funds. If the department is under, leftover funds goes to other departments who go over. If the department is over, they are not guaranteed to be covered for it. "This follows the guideline of "decentralized authority structure" by giving the department complete control over their allocated funds.*
Performance measurements	Coordination	Decentralized	Unchanged from As-Is.
Advisory group	Communication patterns	Mixed	Unchanged from As-Is.
Department operating principles	*Coordination*	*Mixed*	*Department members collaboratively set specific operating principles for the department on a yearly basis that need to be approved by the Faculty. This follows the guidelines of "peer decision making" and "wilful coordination" where the department members work together to decide on their operating principles; i.e. this decision involves all faculty members, instead of just the department head or board.*

Table 4.8 – continued from previous page

Governance Aspect	Property (From Table 4.1)	Centralization	Description
Department strategy	*Coordination*	*Mixed*	*Department members collaboratively set general strategy and vision for the department every three years that need to be approved by the Faculty. This also follows the guidelines of "peer decision making" and "wilful coordination".*

Table 4.9: Peer Production Based Governance Framework: Information Technology

Governance Aspect	Property (From Table 4.1)	Centralization	Description
Authority structure	Coordination	Decentralized	Unchanged from As-Is.
IT adoption (department IT)	Coordination	Decentralized	Unchanged from As-Is.
Approval (department IT)	*Coordination*	*Decentralized*	*IT projects are run by independently by IT, though they sometimes need approval from the department if they are expensive. This approval is granted collaboratively by the department members. This follows the guidelines of a "decentralized authority structure" (the department can decide on it's own projects), and "peer decision making" (controls on the cost of a project are decided on collaboratively).*
IT collaboration	Coordination	Decentralized	Unchanged from As-Is.

Table 4.9 – continued from previous page

Governance Aspect	Property (From Table 4.1)	Centralization	Description
Management of essential central systems	*Coordination*	*Mixed*	*Classification of what is an essential central system is determined collaboratively by the university departments, with each department getting a vote. For systems deemed to be essential, the departments are required to either use the system or interface with it. This follows the guidelines of "peer decision making" and "decentralized authority structure", where large decisions affecting the architecture of the university's IT are determined collaboratively by all departments.*
Management of non-essential central systems	*Coordination*	*Mixed*	*Departments have the choice to opt-in to these systems. Those who choose not to opt-in do not pay for them. This follows the guideline of "wilful coordination".*

4.5 Evaluate Artifact

4.5.1 Iteration 2

Choose Evaluation Strategy

Implementing the proposed solution artifact is not practical or even feasible in the course of a Master's thesis. The time constraints for such an implementation are better suited to a Doctoral thesis where the researcher is able to implement and evaluate the artifact over a longer period of time (i.e. over the course of several years). For this reason, an argumentative evaluation is performed instead of an ex post evaluation in order to determine if the solution artifact, the guidelines of "wilful coordination", "decentralized authority structure", and "peer decision making", would solve the problem explicated in section 4.1. The artifact's demonstration (the Peer Production Governance Framework presented in tables 4.8 and 4.9), however, can be compared to the As-Is Governance Framework (tables 4.4 and 4.5) and the Centralized Governance Framework (tables 4.6 and 4.7), to argumentatively evaluate how well they support the governance activities of a decentralized organization.

In keeping with the principles of design science, it is also important that the proposed Peer Production Governance Framework fulfil the requirements outlined in table 4.3. This is also argumentatively evaluated.

If the artifact's demonstration fulfils these requirements and can be shown to support a decentralized organization (i.e. the case), then we will take this as a weak form of positive confirmation that the artifact itself can be said to fulfil the prescribed requirements and support decentralization.

Carry Out Evaluation

Improved Governance Support of the Proposed Peer Production Governance Framework
The peer production based framework differs from the as-is and centralized governance frameworks in a number of facets. In terms of decision rights allocation, the peer production based framework keeps the same operating principle as the as-is framework – to push decision making as far down to the operational level as possible – whereas a centralized framework would instead keep decision making in the upper levels of management. As most of the staff are operationally-focused (e.g. professors, researchers, and PhDs), this would likely be a sub-optimal situation.

Budgeting in both the as-is and centralized frameworks is centralized, which is in conflict with the decentralized IT management. In the peer production based framework, a mix between centralized and decentralized is instead proposed. Here, the budget is still allocated centrally, however the department then has complete control over their allocated amount. This could potentially remove the conflict as the department would then have the necessary control over their own budget to operate in a manner decentralized from the rest of the organization.

The setting of strategy and overall operating principles for the department is centralized in both the centralized and as-is frameworks. In the peer production framework, a mixed style of governance has been proposed in its place. The decentralized component is that the department members produce the operating principles and strategy using peer production while the centralized component is that approval is still needed from the faculty. This offers the advantage of allowing the department to set a strategy that reflects all aspects of the department (by having input from everyone instead of just the department board) that is still compatible with the rest of the university (as approval is needed by the faculty).

The suggested peer production framework is significantly different from the as-is and centralized frameworks. It seeks to maintain the departmental-independence prevalent in the as-is framework while addressing the incompatible architecture components this results in. This is primarily accomplished through the cooperative classification of essential and non-essential systems, and the difference in governance for the two types. This classification is done in a collaborative manner by the departments, for example by giving each department a vote. Systems classified as essential are required to be used or integrated with by the departments while departments have the option to choose if they want to utilize systems classified as non-essential. These changes are addressed at reconciling differences between the two architecture principles identified previously identified without actually changing the principles. Decision rights are still pushed down and systems are still integrated throughout the organization, but this change in governance addresses the conflict that can arise when a decision is made to implement a decentralized system that the rest of the organization is integrating (as it stands in the as-is framework). In comparison, shifting to centralized governance

(as in the centralized governance framework) would require changing the principle of pushing decision-making down to the operational level. As this is a core principle of the organization, this change would have a significant impact across the entire organization, with no guarantee of it being a positive one.

Fulfilment of Initial Requirements

The first requirement is that the artifact supports the lateral coordination characteristic of a decentralized organization, and the decentralized authority structures and heterogeneous goals that go along with it. The three guidelines of the artifact – being based on peer production – inherently support lateral coordination over vertical coordination. The core characteristic of peer production is that a number of peers work together without a central coordinating authority (as it is in vertical coordination), which supports lateral coordination. The artifact supports decentralized authority structures and decision making (requirement 1.1) by suggesting that individual operational units are responsible for their own decision making. Furthermore, it suggests that the individuals in such a department make decisions collaboratively by giving each individual a vote for major decisions. This further supports heterogeneous goals (requirement 1.2) as each individual (and their respective views and goals) is able to contribute to making decisions.

TOGAF and FEA support governance activities through the use of compliance checking, standards and approval to ensure interoperability and integration of architecture artifacts. The proposed artifact instead suggests less formal style of governance which relies on individuals wilfully coordinating, an authority structure that gives them the freedom to act as they feel is best, and decisions that are made as peers rather than by management.

Being general guidelines, the specifics of how the artifact ensures interoperability and integration of EA components depends on the specific case. An example that fulfils the requirement of supporting governance activities is in the demonstration of the artifact. Here it is proposed that the governance of systems (and therefore the EA artifacts that they result from) is accomplished by collaboratively classifying them as either essential and non-essential. The specific guidelines for interoperability are different for the two classifications. This is a style of governance that follows the guidelines of wilful coordination, decentralized authority structure and peer decision making: individual business units come together to decide on the classification of essential systems, and the implementation of non-essential systems is completely up to discretion of the individual business units.

5. Conclusions and Discussion

5.1 Conclusions

5.1.1   Current EA Support of Decentralization

This thesis sought to determine how existing EA frameworks support decentralization, as reflected in the first research question: *What aspects of existing EA frameworks support decentralized organizations? What aspects do not?*. Answering this research question was based on an extensive literature review of three well-known EA frameworks (TOGAF, FEA, and Zachman) and of decentralized organizations (sections 2.1 and 2.2). To be able to then analyze EA for its support of decentralization, a classification of organizations and relevant properties to decentralization was necessary. Figure 4.1 describes a taxonomy of organizations ranging from *High Centralization* to *High Decentralization* with *Federated* in the centre and classifies many types of organizations that are described in literature. In Figure 4.1, three key organizational properties that differentiate between centralized and decentralized organizations are outlined: geographical dispersion, coordination (authority, decision rights, standards and regulations), and communication patterns. These properties were then used to qualitatively analyze the three EA frameworks for their support of both centralization and decentralization, summarized in 4.2, which is the first of two main contributions of this thesis.

While the analysis uncovered some support for decentralization, the main conclusion drawn is that the EA frameworks of TOGAF, Zachman, and FEA are primarily supportive of centralized and federated organizational structures and therefore fail to address the demands of decentralized organizations. Zachman is unable to support any significant aspect of decentralization due to its reliance on traditional organizational roles and structures on the High Centralization end of the organizational taxonomy. TOGAF does provide some basic support through its ability to have a different architecture for organizational units and by providing space for new methods for the architecture development. It however still mainly relies on hierarchy and central roles responsible for overall coordination and approval. In FEA the conclusions are similar as it primarily supports federated organizational structures where individual units have their own architectures that are coordinated through centralized standards that must be followed.

5.1.2   Principles for an EA supportive of Decentralization

The second goal of this thesis was to design principles for an EA supportive of decentralization, reflected in the second research question: *What are the principles of an EA framework that supports decentralized organizations?*. This research question was answered through a combination of a short literature review on peer-to-peer architectures and a case study on an institute of higher education in Sweden. The answer to this research question in the thesis question is that the principle of *peer production*, and specifically the following peer production based guidelines for governance *wilful coordination*, *decentralized authority structure*, and *peer decision making*, is a principle for an EA supporting decentralized organizations.

The relevance of the case was established in section 4.1.2, where the root causes of a mismatch between the case organization's implicit EA and its organizational structure

were detailed. Here, it was found that the case organization's organizational structure exhibited many of the properties of a decentralized organization while the implicit EA remained highly centralized in many aspects, particularly with respect to decision making.

As part of the "Design and Develop Artifact" step (section 4.3, the general concept of peer-to-peer architectures was introduced and shown, on a high-level, to have some parallels with EA. Two specific principles of peer-to-peer architectures were then outlined, peer production and peer-to-peer trust management, and shown that they could be used as potential principles for an EA that is supportive of decentralization.

The principle of *peer production* was selected to form the basis of the solution artifact in section 4.3.2. This solution artifact was selected to address the issue that the governance aspects of TOGAF, Zachman and FEA tend to assume vertical coordination (as seen in centralized organizations) over horizontal coordination (as seen in decentralized organizations). The solution artifact, composed of three Architecture Principles for a governance framework based on peer production were then outlined. These principles suggested the replacement of formal compliance measures with *wilful coordination*, to implement a "decentralized authority structure" by pushing decision-making authority down to the level of individual business units, and to enable "peer decision making", where decisions are made collaboratively by individuals instead of it residing with a central authority. The feasibility of these guidelines were then demonstrated in section 3.1.2 by outlining the current governance framework ("as-is EA") and then replacing some of the centralized components with peer production based ones. This answers the second research question and is the second main conclusion and contribution of this thesis: **principles from peer-to-peer architectures, and specifically the principle of peer production, have the potential to be able to form the basis for an EA framework that is supportive of decentralization.** A weak form of evaluation, "informed argument", was performed on the demonstration of the solution artifact. Here, the solution artifact was shown to offer improved the (decentralized) case organization improved governance support and fulfil the initial requirements that the artifact shall support lateral coordination and that the artifact shall support governance activities in an organization.

5.1.3 Ethical and Societal Consequences

In keeping with the ethical issue of maintaining a neutral view of EA theory outlined in Section 3.2.2, areas where EA supported and lacked support for decentralization were both identified (table 4.2). Furthermore, in the demonstration of the peer production based EA governance framework, a reference demonstration of a centralized artifact based on traditional EA was also performed (tables 4.6 and 4.7) in order to ensure that traditional EA theory was not ignored.

The conclusions of this thesis are of interest to three groups: the case organization, researchers in the field of EA, and, potentially, other organizations with decentralized structures interested in implementing some form of EA.

For the case organization, the developed EA principle of peer production might be of interest, especially because the demonstration of its application was performed using their organization as a model. For them, the application of this principle as demonstrated in tables 4.8 and 4.9 could offer some improvements to their governance structure. If not,

the problem explication in section 4.1.2 can be taken as third-party feedback into their organizational structure, which offers them insight from an external perspective.

For researchers, this thesis work might be of interest as it highlights some potential issues with traditional EA knowledge while giving some initial insight into how they could be solved. These insights are certainly not conclusive; this research should be positioned as a starting point for future research in the topic of decentralization in EA.

This thesis work might be of interest to organizations that have adopted, or are interested in adopting, a decentralized structure and are looking for insight into how governance can be done in this environment. This thesis would have more of a long-term effect for this group, however, as the ideas presented here likely need to be matured through further research.

5.2 Discussion

The three guidelines presented in section 4.3.2; wilful coordination, decentralized authority structure, peer decision making, are, on their own, highly generalizable. These three guidelines should be applicable to organizations other than the case, however no research on this topic was conducted.

There are two main limitations of the thesis which negatively affect the overall credibility of the results and conclusions: The first is a lack of explicit EA in the case, and the second is that the evaluation of the artifact was limited to an argumentative evaluation. These limitations are primarily due to the difficulty in finding a case organization that is both decentralized and implements an explicit EA.

The EA of the case organization is implicit rather than explicit, i.e. they do not implement an accepted EA framework but they do organize their activities in some manner: their "implicit EA". As an implicit EA does not explicitly make use of the concepts EA frameworks, it becomes difficult to draw parallels – which are therefore very open to interpretation – between the case's EA and the EA frameworks of TOGAF, Zachman, and FEA. Furthermore, the validity of the interpretations, and thus the results, may be somewhat negatively affected by this.

The second main limitation is that there was no opportunity to apply the presented artifact in practice, thus preventing an ex post evaluation of the artifact. The demonstration shows that the artifact is plausible, however the use of an informed argument form of evaluation based on the demonstration means that the artifact should still be considered as immature.

5.3 Future Work

The findings and shortcomings of this thesis can be used to outline a number of concrete suggestions for future research in the area of decentralization in EA.

The generalizability and extensibility of the designed artifact are two topics that would benefit from future research. Currently, the artifact has only been demonstrated in a single organization. Research into the generalizability could look to apply it to a variety of organizations for the purpose of determining if it can be considered suitable for use in all organizations with high degrees of decentralization. An ex post evaluation would be an important component of such research.

An ideal case study that would address the credibility limitations of this thesis would involve one or more case organizations that meet the following criteria:

1. Has a formal EA specification that has also been implemented

2. Exhibits some significant attributes of a decentralized organization (outlined in table 4.1)

3. Has problems with their EA relating to their decentralized characteristics

4. Is interested in implementing changes to resolve these issues and monitoring the results of these changes

Together, these four criteria would allow for direct comparison to modern EA frameworks (due to the formal EA specification) and formal evaluation (due to the ability to implement and evaluate any developed artifacts). Concepts from action research could also be combined with the case study and design science approaches in order to incorporate regular feedback into the design process, thus potentially improving upon the results.

In practice, however, finding a case that meets these four criteria may be difficult. The fourth criteria would be particularly challenging to fulfil, however it might possible as part of a long-term research project. A case that only fulfils the first three criteria would still be quite beneficial as it would allow for the identification of concrete problems which could be mapped back to their source in an EA framework.

Another approach could be to design the EA for a decentralized organization who currently does not have one. This could be used to, at a minimum, obtain feedback on the practical feasibility of such a decentralized EA, or ideally, to implement it and evaluate the results for refining it.

A final suggestion would be to find a decentralized organization that has already implemented a kind of decentralized EA. In this case, this EA could be analyzed to determine its; a) effectiveness, and b) how it tackles the challenges associated with decentralization. It could further be compared to existing EA frameworks such as TOGAF, FEA and Zachman to highlight the major differences and areas where they could be improved by incorporating aspects from the decentralized EA.

Bibliography

[1] The Open Group, *TOGAF Version 9.1*. The Open Group, 2011.

[2] K. E. Pearlson and C. S. Saunders, *Strategic Management of Information Systems*, 4th ed. John Wiley & Sons, 2009.

[3] J. A. Zachman, "John Zachman's Concise Definition of The Zachman Framework," 2008. [Online]. Available: http://www.zachman.com/about-the-zachman-framework

[4] Federal Enterprise Architecture Program Management Office, "FEA Practice Guidance," 2007.

[5] J. Fulk and G. DeSanctis, "Electronic communication and changing organizational forms," *Organization science*, vol. 6, no. 4, pp. 337–349, 1995.

[6] S. H. Kaisler, F. Armour, and M. Valivullah, "Enterprise architecting: Critical problems," in *System Sciences, 2005. HICSS '05. Proceedings of the 38th Annual Hawaii International Conference on*, 2005, pp. 224b–224b.

[7] C. Lucke, S. Krell, and U. Lechner, "Critical issues in enterprise architecting–a literature review," in *AMCIS 2010 Proceedings. Paper 305.*, 2010. [Online]. Available: http://aisel.aisnet.org/amcis2010/305

[8] S. Bente, U. Bombosch, and S. Langade, *Collaborative Enterprise Architecture: Enriching EA with Lean, Agile, and Enterprise 2.0 Practices*. Waltham, MA: Morgan Kaufmann, 2012.

[9] E. Najafi and A. Baraani, "Kasra framework: A service oriented enterprise architecture framework (soeaf)," in *Services (SERVICES-1), 2010 6th World Congress on*. IEEE, 2010, pp. 172–173.

[10] R. Sessions. (2007) A Comparison of the Top Four Enterprise-Architecture Methodologies. [Online]. Available: http://msdn.microsoft.com/en-us/library/bb466232.aspx

[11] P. Johannesson and E. Perjons, *A Design Science Primer*, 1st ed. CreateSpace, 2012. [Online]. Available: http://designscienceprimer.wordpress.com

[12] J. Schekkerman, *How to survive in the jungle of enterprise architecture frameworks: Creating or choosing an enterprise architecture framework*, 2nd ed. Trafford Publishing, 2004.

[13] Gartner Inc, "Enterprise Architecture (EA)." [Online]. Available: http://www.gartner.com/it-glossary/enterprise-architecture-ea/

[14] J. W. Ross, P. Weill, and D. Robertson, *Enterprise architecture as strategy: Creating a foundation for business execution*. Harvard Business Press, 2006.

[15] M. Lankhorst, *Enterprise architecture at work: Modelling, communication and analysis*, 2nd ed. Heidelberg: Springer, 2009.

[16] Z. I. Inc. (2013) Zachman Interational: The Official Home of the Zachman Framework. [Online]. Available: http://www.zachman.com

[17] J. A. Zachman. (2000) Conceptual, Logical, Physical: It Is Simple. [Online]. Available: http://www.zachman.com/ea-articles-reference/58-conceptual-logical-physical-it-is-simple-by-john-a-zachman

[18] P. Sachdeva *et al.*, "Analytical framework for the organization and structure of nars." in *Organization and structure of national agricultural research systems: selected papers....*, 1990, pp. 1–8.

[19] M. G. Jacobides, "The inherent limits of organizational structure and the unfulfilled role of hierarchy: Lessons from a near-war," *Organization Science*, vol. 18, no. 3, pp. 455–477, 2007.

[20] B. McKelvey, *Organizational systematics: Taxonomy, evolution, classification.* Univ of California Press, 1982, vol. 72.

[21] P. Rich, "The organizational taxonomy: definition and design," *Academy of Management Review*, pp. 758–781, 1992.

[22] H. Mintzberg, "The structuring of organizations: A synthesis of the research," *University of Illinois at Urbana-Champaign's Academy for Entrepreneurial Leadership Historical Research Reference in Entrepreneurship*, 1979.

[23] ——, "Organizational design: fashion or fit?" *Harvard Business Review*, vol. 59, no. 1, pp. 103–116, 1981.

[24] S. P. Robbins, *Organisational behaviour: Concepts, controversies and applications: Australia and New Zealand.* Royal Victorian Institute for the Blind. Special Request Service, 1997.

[25] F. Luthans, *Organizational behavior.* McGraw-Hill/Irwin, 2006. [Online]. Available: http://books.google.fr/books?id=1axXAAAAYAAJ

[26] J. D. Thompson, *Organizations in action: Social science bases of administrative theory.* Transaction Pub, 1967.

[27] M. K. Ahuja and K. M. Carley, "Network structure in virtual organizations," vol. 3, no. 4. Wiley Online Library, 1998, pp. 0–0.

[28] L. M. Applegate, J. I. Cash, and D. Q. Mills, *Information technology and tomorrow's manager.* Harvard Business Review, Reprint Service, 1988.

[29] L. G. Bolman and T. E. Deal, *Reframing Organizations*, 4th ed. San Francisco, California: John Wiley & Sons, 2008.

[30] Valve Corporation. (2012) Valve Handbook for New Employees. [Online]. Available: www.valvesoftware.com/company/Valve_Handbook_LowRes.pdf

[31] L. M. Camarinha-Matos and H. Afsarmanesh, "Collaborative networks: a new scientific discipline," *Journal of Intelligent Manufacturing*, vol. 16, no. 4-5, pp. 439–452, 2005.

[32] M. Bengtsson and S. Kock, "Coopetition in business networks–to cooperate and compete simultaneously," *Industrial marketing management*, vol. 29, no. 5, pp. 411–426, 2000.

[33] J. Rockart, M. Earl, and J. Ross, "Eight imperatives for the new IT organization," *Sloan management review*, pp. 43–56, 1996.

[34] M. Osterloh and B. S. Frey, "Motivation, knowledge transfer, and organizational forms," *Organization science*, vol. 11, no. 5, pp. 538–550, 2000.

[35] P. Weill, "Don't just lead, govern: How top-performing firms govern it," *MIS Quarterly Executive*, vol. 3, no. 1, pp. 1–17, 2004.

[36] R. L. Daft and A. Y. Lewin, "Where are the theories for the new organizational forms? An editorial essay," *Organization Science*, vol. 4, no. 4, pp. i–vi, 1993.

[37] H. M. Caruso, T. Rogers, and M. H. Bazerman, *Boundaries Need Not be Barriers: Leading Collaboration Among Groups in Decentralized Organization.* Harvard Business School, 2008.

[38] F. B. Vernadat, "Enterprise modeling and integration (EMI): Current status and research perspectives ," *Annual Reviews in Control*, vol. 26, no. 1, pp. 15–25, 2002. [Online]. Available: http://www.sciencedirect.com/science/article/pii/S1367578802800062

[39] The Business Rules Group. (2010) The Business Motivation Model: Business Governance in a Volatile World. [Online]. Available: http://www.businessrulesgroup.org/bmm.shtml

[40] W. Roshen, *SOA-Based Enterprise Integration: A Step-by-Step Guide to Services-based Application.* McGraw-Hill, Inc., 2009.

[41] Object Management Group, "Business process model notation (bpmn) version 2.0," *OMG Specification*, 2011.

[42] A.-W. Scheer, O. Thomas, and O. Adam, "Process modeling using event-driven process chains," *Process-Aware Information Systems*, pp. 119–146, 2005.

[43] O. M. Group. (2011) UML 2.4.1. [Online]. Available: http://www.omg.org/spec/UML/2.4.1/

[44] M. Weske, *Business process management.* Springer, 2012.

[45] J. Gordijn and H. Akkermans, "E3-value: Design and evaluation of e-business models," *IEEE Intelligent Systems*, vol. 16, no. 4, pp. 11–17, 2001.

[46] P. Hrubỳ, J. Kiehn, and C. V. Scheller, *Model-driven design using business patterns.* Springer, 2006.

[47] P. Johannesson, "Lecture 2: Business Models Overview," unpublished, Stockholm University, Stockholm, 2011.

[48] J. Stirna and A. Persson, "Ten Years Plus with EKD: Reflections from Using an Enterprise Modeling Method in Practice," in *Proceedings of the 11th International Workshop on Exploring Modeling Methods in Systems Analysis and Design (EMMSAD 2007)*, 2007, pp. 99–108.

[49] J. A. Bubenko, A. Persson, and J. Stirna, "User Guide of the Knowledge Management Approach Using Enterprise Knowledge Patterns. Deliverable D3, IST Programme project Hypermedia and Pattern Based Knowledge Management for Smart Organisations, project no. IST-2000-28401," Royal Institute of Technology, Department of Computer and Systems Sciences, Stockholm, Tech. Rep., 2001.

[50] A. R. Hevner, S. T. March, J. Park, and S. Ram, "Design science in information systems research," *MIS Quarterly*, vol. 28, no. 1, pp. 75–105, 2004.

[51] M. Denscombe, *The good research guide: for small-scale social research projects.* Open University Press, 2010.

[52] D. Acemoglu, P. Aghion, C. Lelarge, J. Van Reenen, and F. Zilibotti, "Technology, information, and the decentralization of the firm," *The Quarterly Journal of Economics*, vol. 122, no. 4, pp. 1759–1799, 2007.

[53] S. Saroiu, P. K. Gummadi, and S. D. Gribble, "Measurement study of peer-to-peer file sharing systems," in *Electronic Imaging 2002*. International Society for Optics and Photonics, 2001, pp. 156–170.

[54] Y. Benkler, *The wealth of networks: How social production transforms markets and freedom.* Yale University Press, 2006.

[55] K. Aberer and Z. Despotovic, "Managing trust in a peer-2-peer information system," in *Proceedings of the tenth international conference on Information and knowledge management.* ACM, 2001, pp. 310–317.

[56] T. Speckert, I. Rychkova, J. Zdravkovic, and S. Nurcan, "On the changing role of enterprise architecture in decentralized environments: State of the art," in *TEAR Workshop 2013, the 17th IEEE International EDOC Conference*, 2013, short paper.

[57] I. Rychkova, J. Zdravkovic, and T. Speckert, "Challenges of ea methodologies facing progressive decentralization in modern organizations," in *The 6th IFIP WG 8.1 Working Conference on the Practice of Enterprise Modeling (PoEM 2013)*, 2013, short paper. [Online]. Available: http://ceur-ws.org/Vol-1023/paper2.pdf

Appendix: Interview Questions

Interviews with the Head of Graduate Education & the Vice-Head of the Department

- Does the department have a set of operating principles?

- According to the organizational chart, units, centres and some administrative staff have some sort of "decision making" influence over the Head of the Department. What exactly do these rights entail?

- What level of autonomy do the various units and centres have?

  - Do they run themselves, or are they managed by the head of the department?

  - Do they manage their own IT systems, or do they exclusively utilize the department's systems (or some combination thereof)?

  - Are there any control or performance measures that the centres and units are measured by?

- How autonomous is the department within the institution as a whole?

- Current processes at the department:

  - How is project management performed?

  - How are systems managed?

  - How does the department manage its portfolios of applications and information?

  - What general process is behind system design and development?

  - Does the department keep an inventory of its skills and capabilities?

- Does the department monitor some form of "return on investment"?

- Does the department have any high-level guidelines or rules for its interactions with outside organizations?

  - Do the department's IT systems offer support for these interactions?

- Are there any key legal issues (e.g. laws or directives from Swedish/EU government) that have a significant effect on the department's operations?

- Does the department use IT systems to support their managerial or governance activities?

- What are the primary research-related operations at the department?

  - How are they managed?

  - Who is responsible for their governance?

- Does the department have any control or performance measures for research activities?

- How does the department manage collaborations with other organizations (e.g. with other universities or companies)?

- What IT systems are used by the department to support their research activities?

- Does the department follow a set of operating principles for education activities?

- What are the primary education-related operations at the department?

  - How are they managed?
  - Who is responsible for their governance?

- Does the department have any control or performance measures for educational activities?

- How does the department manage agreements/interactions with other organizations (for example, with respect to admissions, exchanges, or teaching in conjunction with other institutions)?

- What IT systems are used by the department to support their education/teaching activities?

- Does the department follow a set of operating principles for education activities?

Interview with the Head of IT

- What different systems are under your control?

  - Are these all separate systems, or are some of them simply front-ends to the same system.

- What are the primary operations of the IT department?

- How do you "evolve/change" your IT systems (for example, domain migration)?

  - Do the directives come from above?
  - Are you able to do as you see necessary without explicit approval?
  - How are the changes managed?

- Do you cooperate with other the rest of the institution on other IT projects?

  - If yes, how is this managed?
  - Does this lead to conflicts?
  - Do these cooperations have lead to improvements for everyone?

- How do you measure/evaluate your performance?

- How is the Institution budget distributed?

- Does this department compete with other departments in any way?

- Is it important for this department to maintain an identity that is separate from the rest of the institution?

Interview with the Head of Undergraduate Education

- How do you "evolve/change" your education programs?

    – Do the directives come from above?

    – Are you able to do as you see necessary without explicit approval?

- Do you cooperate with other departments for any degree programs?

    – If yes, how is this managed?

- Do you cooperate with other faculties for any degree programs?

    – If yes, how is this managed?

- How do you measure/evaluate your performance (informal and formal)?

- Are the different education programs organized by the different units?

- How is the Institution budget distributed?

- Does this department compete with other departments in any way?

- Is it important for this department to maintain an identity that is separate from the rest of the institution?