



NTNU – Trondheim
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Integration Governance

A NTNU case study, how Enterprise modeling
and Architecture improves Integration
Governance

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Problem description

Through the master thesis the student shall study and evaluate how Enterprise modeling and Architecture improves Integration Governance at NTNU supported by TOGAF. Case to be studied is TIA (Service Oriented Information Architecture at NTNU). The student also shall research best practice for Integration Governance at comparable enterprises. By comparing and analyzing best practice with TOGAF and improvements identified by Enterprise modeling the student shall propose an Integration Governance model for NTNU and steps for implementation.

This necessitates following main activities:

1. Literature study and study of relevant NTNU internal documents.
2. Study TIA Case. Focus on FS, Common Student System.
3. TIA analysis supported by TOGAF.
4. Create Enterprise model and Architecture. Architectural artifacts such as:
 - Information model.
 - Security and classification of information.
5. Conduct best practice surveys at minimum three comparable enterprises.
6. Best practice analysis.
7. Align best practice analysis with Enterprise model and Architecture.
8. Evaluation.
9. Create integration governance model for NTNU.
10. Propose steps for implementation of Integration Governance at model at NTNU.

Expected outcome is an Integration Governance model for NTNU. The main purpose of the Integration Governance model is to govern how decisions are made among stakeholders concerning integration at NTNU.

Abstract

The NTNU IT-Division has in recent years experienced a continuously increasing complexity in governance related to data integration and data flow in the NTNU organization. The demand for updated and quality assured data is in society constantly growing. This determines requirements for security, protection of privacy, tracking, aspects of law, technical aspects and economy (Life cycle costs for systems). These requirements necessitate improved organization and formal cooperation at NTNU (2). To improve the situation this master thesis introduces and defines the concept Integration Governance.

To improve this situation this master thesis aims to find a best practice for Integration Governance. And it aims to define a target model for Integration Governance model and steps for implementation at NTNU. The purpose of the Integration Governance model for NTNU is to govern how decisions are made among stakeholders concerning integration at NTNU. A best practice survey is designed and conducted at comparable enterprises. By studying and analyzing best practice of enterprises a set of best practice principles for Integration Governance are defined.

The best practice principles are input to Enterprise model and Architecture (EA) To-Be. An actual practice for Enterprise model and Architecture (EA) As-Is at NTNU is studied as well. EA To-Be is aligned with the concept Foundation of Execution (20) and defines the best practice Integration Governance model in this master thesis. The gap between EA As-Is and EA To-Be is the basis for the gap analysis. The best practice Integration Governance model is evaluated by several evaluation methods. SEQUAL a framework for evaluating model quality is one evaluation method applied. After response from model evaluation an Integration Governance model for NTNU is presented. Steps for implementing an Integration Governance model for NTNU is proposed. This based on gap analysis and model evaluation.

In this master thesis the results from best practice analysis and model evaluation indicate that Enterprise model and Architecture improves Integration Governance. Further the results from analysis of best practice and model evaluation indicate that there is a best practice for Integration Governance. In addition the results from analysis of best practice and model evaluation indicate that IT-operations practice influence Integration Governance practice to a less degree.

Preface

This master thesis was written as a part of Master of Science program in Informatics, Data and Information Management, at the Department of Computer and Information Science (IDI) at the Norwegian University of Science and Technology (NTNU).

The subject of this master thesis report is an assignment given by my employer the NTNU IT-Division, section manager Stein Stendahl. Professor John Krogstie has been supervisor and Adjunct Associate Professor Sobah Abbas Petersen has been co-supervisor.

I would like to thank Sobah Abbas Petersen for giving me insightful and valuable feedback through guidance and giving me challenging questions and task related to this master thesis. And I would like to thank John Krogstie for inspiration and valuable knowledge.

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In would like to thank the external interviewees for their contributions: Mathias Meisfjordskar at USIT/UIO, CIO for a large commercial supplier of IT infrastructure, Knut-Olav Traa at Statkraft, Morten Vaagen and Jarle Boland at Sykehuspartner, Frode Junge and Baard Grodem at Hemit, Senior Consultant IT-operations for a bank and Harald Wesenberg at Statoil. In partical I would like to thank the Senior Consultant IT-operations for a bank and Harald Wesenberg at Statoil for valuable insights through conversations in the early stage of this master thesis.

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Abbreviations

Symbol	=	definition
BI	=	Business Intelligence
CEO	=	Chief Executive Officer
COTS	=	Commercial off-the-shelf
Cristin	=	Current Research Information System In Norway
CRM	=	Customer Relations Management
DBH	=	Database for Higher Education in Norway
DIFI	=	Agency for Public Management and eGovernment (Norwegian translation)
DMF	=	DMF Faculty of Medicine NTNU
EA	=	Enterprise Architecture
EAI	=	Enterprise Architecture Integration
FS	=	Felles Student System (Common Student System)
Gartner	=	Leading information technology research and advisory company
HPSM	=	Hewlett-Packard Service Manager
HR	=	Human Relations
IAM	=	Identity and Access Management
ICT	=	Information and Communications Technology
ITIL	=	Information Technology Infrastructure Library
KPI	=	Key Performance Indicator
LMS	=	Learning Management System
NTNU	=	Norwegian University of Science and Technology
Paga	=	NTNU payroll and personnel system
Prince ₂	=	A project Method
REST	=	Representational state transfer
RUP	=	Rational Unified Process
SOA	=	Service Oriented Architecture
SOAP	=	Simple Object Access protocol
SQL	=	Structured Query Language
TIA	=	Norwegian acronym for: Service oriented Information Architecture
TOGAF	=	The Open Group Architecture Framework
UIO	=	University of Oslo
USU	=	Extended Service Extraction from Paga
Uninett	=	UNINETT develops and operates the Norwegian national research and education network
XML	=	Extensible Markup Language

Introduction

This introduction chapter presents the motivation of writing this master thesis, project context, the problem definition, hypothesis, research method, research process and structure of the report.

1.1 Motivation

The NTNU-IT Division has in recent years experienced a continuously increasing complexity in governance related to data integration and data flow in the NTNU organization. The demand for updated and quality assured data is in society constantly growing. This determines requirements for security, protection of privacy, tracking, aspects of law, technical aspects and economy (Life cycle costs for systems). These requirements necessitate improved organization and formal cooperation at NTNU (2). To improve this situation the NTNU-IT Division has given me an assignment as follows (2):

1. Find best practice for Integration Governance of integration processes and IT-operation processes related to integration.
 - Conduct research on best practice at comparable enterprises.
It is a goal to find a well proven framework or method.
2. Describe requirements and demands for Integration Governance regarding to or related to:
 - Orders. Delivery of integrations to new projects or systems.
 - Change in source system, interfaces or target system.
Meaning change in applications
 - Change of requirements by system owner or end user.
Meaning change in work processes.
 - Change reasoned by technical requirements.
Meaning changes in infrastructure.

- Security and categorization of information.
 - Information model and context.
Data information and have different meaning depending on context.
3. Define target for Integration Governance (model) and steps for implementation at NTNU.
 4. Implement best practice by defined steps.

Integration and data-flow range several NTNU enterprise processes as: Administration of Studies, Communication, Organization, Economy/Administration, HR, IAM (Identity and Access management) and Business Intelligence (BI).

This master thesis aim to provide a holistic view on this problem situation.

1.2 Project Context

To understand the project context it is important important to get an overview of the Norwegian University of Science and Technology (NTNU) organization, the responsibilities of the NTNU IT-Division and the scope of integration at NTNU.

The Norwegian University of Science and Technology (NTNU) is Norway's primary institution for educating the nation's future engineers and scientists. The university also has strong programmes in the social sciences, teacher education, the arts and humanities, medicine, architecture and fine art (3). NTNU is Norway's second largest university with an annual budget of USD 930 million. The university has 48 departments organized in 7 faculties and a central administration. There are about 23000 students and 5000 employees at NTNU. And about 3500 bachelor and master degrees are awarded each year (4).

The NTNU IT-Division is organized in the central administration under the organization director, and has around 100 employees. The main responsibilities for NTNU IT-Division are (5):

- IT operations for common and basis services for NTNU
- Develop web based solutions for NTNU
- Advisory activities for the NTNU organization in IT
- An important responsibility is integrations

Integration supports the following enterprise processes at NTNU: Administration of Studies, Research, Communication, Organization, Economy/Administration, HR, IAM and BI. NTNU is a relative large organization with many enterprise processes. Therefore there are many process owners and other stakeholders as well. This means that challenges related to integration both are technological and organizational.

Integration has been so far been implemented with legacy systems and legacy technology. The integration system was initially build for one purpose and later applied for many other purposes. This situation has lead to little flexibility and long time to deliver new functionality and products to customers (6). To improve this situation the TIA project and the NTNU Data Warehouse project were started. The new TIA Technology (7) should be able to meet "Time to market" requirements. Further the Data Warehouse project (8) was implemented to support the NTNU Business Intelligence System.

Despite, major improvements in integration technology there are unsolved issues regarding cooperation and organizing amongst stakeholders concerning integration at NTNU (2). Relevant questions to ask are: Who own the processes at NTNU, who own the data at NTNU and is the ownership clearly defined? And how are decisions regarding IT made? These issues affect Integration Governance at NTNU.

1.3 Problem description

Through the master thesis the student shall study and evaluate how Enterprise modeling and Architecture improves Integration Governance at NTNU supported by TOGAF. Case to be studied is TIA (Service Oriented Integration Architecture at NTNU). The student also shall research best practice for Integration Governance at comparable enterprises. By comparing and analyzing best practice with TOGAF and improvements identified by Enterprise modeling the student shall propose an Integration Governance model for NTNU and steps for implementation.

This necessitates following main activities:

1. Literature study and study of relevant NTNU internal documents.
2. Study TIA Case. Focus on FS, Common Student System.
3. TIA analysis supported by TOGAF.
4. Create Enterprise model and Architecture. Architectural artifacts such as:
 - Information model.
 - Security and classification of information.
5. Conduct best practice surveys at minimum three comparable enterprises.
6. Best practice analysis.
7. Align best practice analysis with enterprise model and architecture.
8. Evaluation.
9. Create Integration Governance model for NTNU.
10. Propose steps for implementation of Integration Governance at model at NTNU.

Expected outcome is an Integration Governance model for NTNU. The main purpose of the Integration Governance model is to govern how decisions are made among stakeholders concerning integration at NTNU.

1.4 Hypothesis

In this master thesis the hypotheses are:

- Hypothesis 1, H1: The main hypothesis: Enterprise Modeling and Architecture improves Integration Governance.
- Hypothesis 2, H2: There is a best practice for Integration Governance.
- Hypothesis 3, H3: IT-operations practice influence Integration Governance practice to a less degree.

1.5 Research method

This section describes the research methods applied in this survey. Research methods applied in this thesis are Literature study, study of documents, conversations, surveys, analysis of best practice from surveys, case studies, modeling analysis, model evaluation and analysis of hypotheses.

1.5.1 Literature study

This subsection describes literature study. Publications and articles in following disciplines are studied: Enterprise Modeling, Enterprise Architecture, IT Governance, SOA Governance, Integration, System integration, Data Integration and Enterprise Integration Patterns. Important concepts from the literature study are defined in chapter 2, Definition of concepts. A challenge was finding literature that could define a best practice for Integration Governance. In particular following publications are studied in depth providing concepts and basis for this master thesis:

1. Enterprise Architecture as a Strategy (20)
2. IT Governance, How Top Performers Manage IT Decision Rights for Superior Results (23)
3. SOA Governance Framework Technical Standard (26)
4. TOGAF Version 9.1 (45)

1.5.2 Study of documents

This subsection describes study of documents: Internal NTNU documents and external documents received in interviews and conversations. Study of Internal NTNU documents as project reports and NTNU architecture documents are studied to define actual NTNU

practice regarding Integration Governance. External documents received in interviews and conversations with external enterprises are studied attempting to define best practice for Integration Governance, i.e Appendix N.

1.5.3 Conversations

Several conversations were held to get an overview over relevant literature, interesting cases studies and Integration Governance practices. In the early phase of the master thesis work the conversations were important to get insight in important concepts and literature concerning best practice for Integration Governance. Further conversations were important to provide insights and overview over relevant NTNU documents and actual practice for NTNU concerning Integration Governance.

1.5.4 Surveys

This subsection describes an overview over surveys conducted. 7 survey interviews were conducted at external enterprises to retrieve data and information concerning best practice. And 5 survey interviews were conducted at NTNU to retrieve data and information concerning actual practice. The surveys are conducted through face to face interviews based on the questionnaire (Appendix A). The questionnaire is divided in three levels: Strategic, tactical and operational level. The tactical level in the questionnaire aim to categorize the enterprises in the survey by degree of integration of business processes and degree of standardization of business processes (20).

1.5.5 Analysis of best practice from surveys

This subsection describes analysis of practice from surveys. Each answer from the survey is scored. The questionnaire is divided in three levels: Strategic, tactical and operational. This makes it possible to present a table with enterprises ranked divided in strategic, tactical and operational level with survey score (table 4.1). The enterprises categorized representing a best practice for Integration Governance are compared (Appendix D) and studied further in Qualitative analysis (Appendix E). Principles for Integration Governance best practice are derived from Qualitative analysis (Appendix E).

1.5.6 Case studies

The case studies describes studies of TIA (Service Oriented Information Architecture) and FS (Common Student System) described in chapter 6. TIA case.

1.5.7 Modelling analysis

This subsection describes modelling analysis conducted in this master thesis. Modelling analysis is supported by TOGAF (45). Based on actual at NTNU from conversations and surveys an Enterprise and model Architecture As-Is (Appendix G) is created supported by TOGAF. And based on principles for Integration Governance best practice an Enterprise and model Architecture To-Be (chapter 8) is created supported by TOGAF. Further a Best

practice Integration Governance model is derived from Enterprise and model Architecture To-Be and Foundation of Execution (20).

1.5.8 Model evaluation

This subsection describes model evaluation conducted (chapter 10). The Best practice Integration Governance model is evaluated. Does the model meet its purpose? And does the model fit to NTNU? Evaluation methods conducted are: Quantitative evaluation by interviews (Appendix J), evaluation based on competency questions (QC), qualitative evaluation (Appendix K) and evaluation by SEQUAL.

1.5.9 Analysis and discussion

The model evaluation is the main contribution to determine if the main hypothesis H1 is defended: "Enterprise Modeling and Architecture improves Integration Governance". See chapter 13. This applies for H2: "There is a best practice for Integration Governance" and H3: "IT-operations practice influence Integration Governance practice to a less degree" as well. Further the Integration Governance best practice analysis (chapter 4) indicate to defend the hypotheses.

1.6 Research process

Research process contains several well defined activities. This is an iterative research process. See figure 1.1 below.

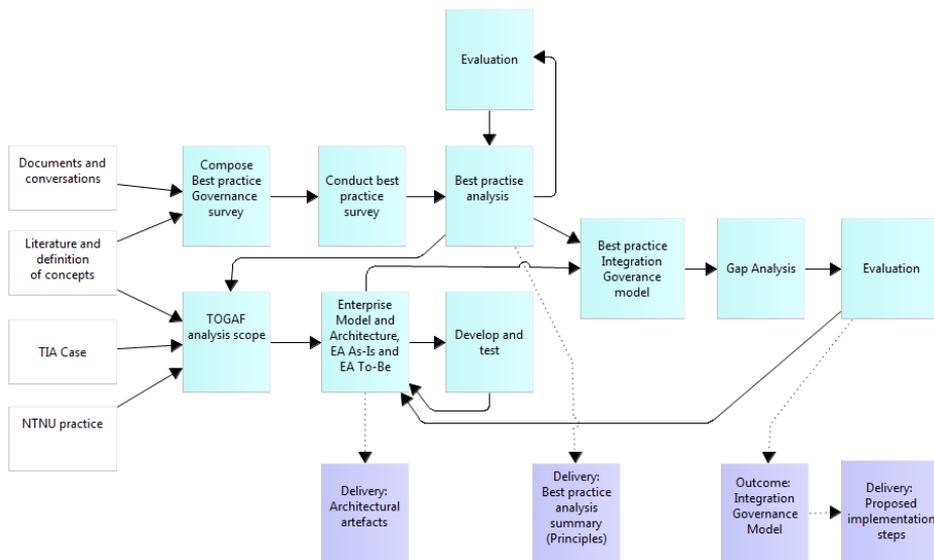


Figure 1.1: Research process

1.7 Structure of the report

This section presents a short introduction to all the chapters of this report. The structure of the report aim follow the research process described in figure 1.1.

This report and master thesis is formed with the intention to solve the assignment given in chapter 1.1 Motivation and accomplish the main tasks described in chapter 1.3 Problem description.

Chapter 2, Definition of concepts

Chapter 2 defines the two concepts: Integration and Governance. Enterprise Architecture and Enterprise modeling are two concepts often perceived in relation to IT-Governance and Integration. This chapter introduce and defines the concept of Integration Governance which is a contribution from the author of this master thesis. Finally chapter 2 introduce Enterprise Architecture as a strategy (23) and the concept Foundation of Execution (23).

Chapter 3, Integration Governance best practice survey

Chapter 3 defines reasoning behind questions and questionnaire applied for finding best practice for Integration Governance. The reasoning behind questions and questionnaire is a contribution from the author of this master thesis.

Chapter 4, Integration Governance best practice analysis

Chapter 4 presents the best practice analysis for the surveys conducted. Base on best practice analysis this chapter presents some general principles for Integration Governance. The best practice analysis and the general principles for Integration Governance are contributions from the author of this master thesis.

Chapter 5, NTNU practice: Enterprise Architecture and IT-governance

Chapter 5 describes actual Integration Governance practice at NTNU.

Chapter 6, TIA case

Chapter 6 describes the TIA case (Service oriented Information Architecture) at NTNU in which is given by the problem definition in chapter 1.3: Study TIA Case. Focus on FS, Common Student System.

Chapter 7, TOGAF Analysis Scope

Chapter 7 defines the scope for TOGAF analysis based on actual Integration Governance practice at NTNU (chapter 5), As-Is and best practice Integration Governance practice (chapter 4), To-Be.

Chapter 8, Enterprise Model and Architecture To-Be

Chapter 8 describes Enterprise Model and Architecture To-Be based on best practice principles for Integration Governance with focus on TIA (Service oriented Information Architecture) and FS, Common Student System. The Enterprise Model and Architecture To-Be is a contribution from the author of this master thesis.

Chapter 9, Best practice Integration Governance model and gap analysis

Chapter 9 aim to align the Enterprise Model and Architecture To-Be (chapter 8) with Foundation of Execution (20). And it aim to present a gap analysis identifying gaps between actual practice and best practice. The practice Integration Governance model and gap analysis are contributions from the author of this master thesis.

Chapter 10, Model evaluation

Chapter 10 presents a model evaluation of best practice Integration Governance model. Does the model meet its purpose? And does the model fit to NTNU? The Model evaluation is a contribution from the author of this master thesis.

Chapter 11, Integration Governance Model

Chapter 11, presents Integration Governance model for NTNU based on best practice Integration Governance model. The Integration Governance model for NTNU is adjusted after model evaluation conducted in chapter 10. The Integration Governance Model is a contribution from the author of this master thesis.

Chapter 12, Implementation steps

Chapter 12, presents proposed implementation steps for implementing an Integration Governance model for NTNU. The implementation steps are based on gap analysis and model evaluation. The Implementation steps are contributions from the author of this master thesis.

Chapter 13, Analysis and discussion

Chapter 13, analyze and discusses the main hypotheses for this thesis presented in chapter 1.4 related to Model evaluation in chapter 10 and Integration Governance best practice analysis in chapter 4. This analysis and discussion is a contribution from the author of this master thesis.

Chapter 14, Summary

Chapter 14, presents the summary of this report. And aim to summarize the activities related to the Problem description chapter 1.3. The main activities in the problem description are presented with regards to accomplishment.

Chapter 15, Further work

Further work is divided in two categories: Academic work and work for the principal the NTNU IT Division described in chapter 12 Implementation steps.

Appendices

Appendices contain, the Questionnaire, External interviews, NTNU internal interviews, Comparison of the 3 best practices, Qualitative best practice analysis, Short description of TOGAF, The NTNU IT Division ITIL processes, Enterprise Model and Architecture As-Is, Conversations, Model development and testing, Model evaluation interviews, Qualitative model evaluation, List of architectural artifacts, Draft for scientific article and the Statoil Governance document: IT Components.

All Appendices are contributions from the author of this master thesis except: The Short description of TOGAF, The NTNU IT Division ITIL processes and the Statoil Governance document (IT Components)

Definition of concepts

Integration Governance consist of two concepts: Integration and Governance. Enterprise Architecture and Enterprise modeling are two concepts often perceived in relation to IT-Governance and Integration. The perception of these concepts might be ambiguous or overlap. Therefore unambiguous definitions of these concepts are important. All definitions of concepts are collected from literature, publications and Wikipedia except for the Integration Governance concept which is defined in this thesis and in this chapter.

2.1 Integration

Integration has meaning in several contexts such as Social integration, Economic integration and Integration in Mathematics (9). System Integration and Information System Integration are the relevant contexts for Information Technology.

2.1.1 System Integration

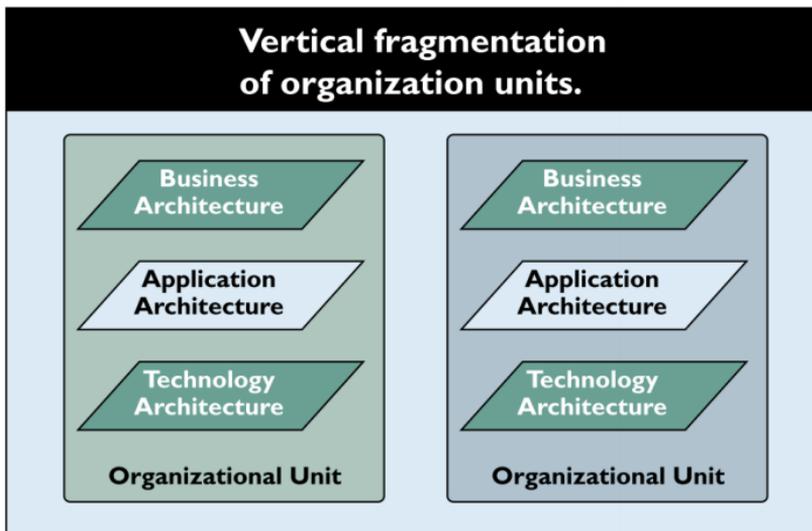
In engineering, system integration is defined as the process of bringing together the component subsystems into one system and ensuring that the subsystems function together as a system (10). In information technology, systems integration is the process of linking together different computing systems and software applications physically or functionally to act as a coordinated whole (10).

2.1.2 Information System Integration

William Hasselbring's article Information System Integration (12) illustrates the challenges related to integration: For information systems, it is increasingly difficult to draw a line around an application system and say that you own and control it. For example, as value chains extend beyond enterprises, supplier and customer systems become part of each others information architectures (12). Figure 2.1 illustrates such a vertical fragmentation

of organizational units. Each unit may be structured within three architectural layers, as described in the following (12):

- The business architecture layer defines the organizational structure and the work flows for business rules and processes. It is a conceptual level expressed in terms meaningful to actual users of application systems.
- The application architecture layer defines the actual implementation of the business concepts in terms of enterprise applications. At this layer, it is the central goal to provide the glue between the application domain described in the business architecture and the technical solutions described in the technology architecture.
- The technology architecture layer defines the information and communication infrastructure. At this layer, IT is challenged to achieve the business requirements.

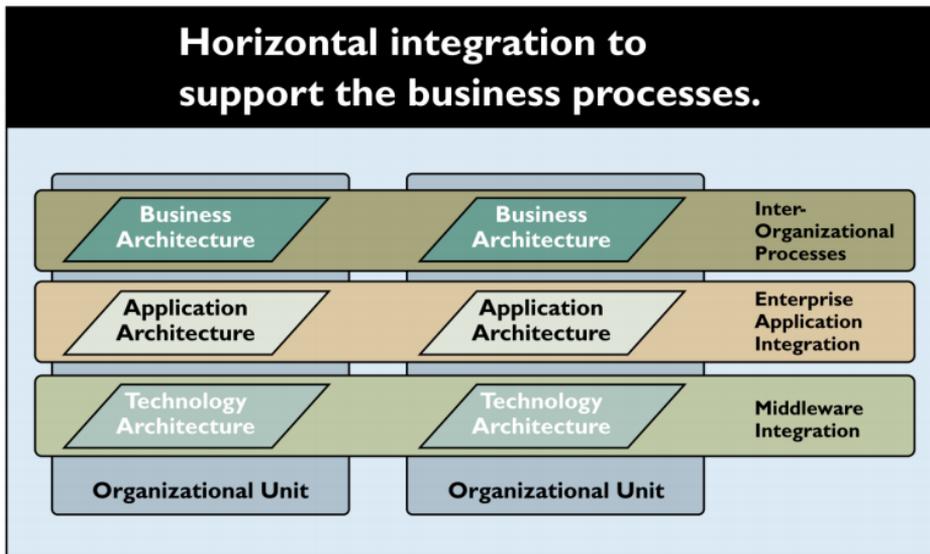


Wilhelm Hasselbring et al. (2000). "Information system integration", Communications of the ACM, Volume 43, Issue 6 (June 2000), Pages: 32-38

Figure 2.1: Vertical fragmentation of organization units

The vertical fragmentation of organization units often refers to as silos (11). It is important to realize that Figure 2.1 does not adequately reflect the reality. In practice, the business architectures of the individual organizational units cannot be treated in isolation: the business processes of cooperating units are highly interrelated and should be handled as such. Figure 2.2 illustrates this situation (12).

Certain kinds of interactions among computer systems resemble interactions among people; thus, it is important to consider all levels when integrating those systems. A horizontal integration of the layers is required to support the business processes effectively, as indicated here (12).



Wilhelm Hasselbring et al. (2000), "Information system integration", *Communications of the ACM*, Volume 43, Issue 6 (June 2000), Pages: 32-38

Figure 2.2: Horizontal integration to support the business processes

2.1.3 Integration options

There is more than one approach for integrating applications. Each approach addresses some of the integration criteria better than others. The various approaches can be summed up in four main integration styles (13):

1. File Transfer: Have each application produce files of shared data for others to consume, and consume files that others have produced.
2. Shared Database: Have the applications store the data they wish to share in a common database. Comment: An example can be a Data Warehouse.
3. Remote Procedure Invocation: Have each application exposes some of its procedures so that they can be invoked remotely, and have applications invoke those to run behavior and exchange data. Comment: An example can be REST or SOAP protocols which are often referred to as web-services (14). Web-services are often associated with Service Oriented Architecture (SOA) (15).
4. Messaging: Have each application connect to a common messaging system, and exchange data and invoke behavior using messages. Comment: An example can be JMS or MSMQ.

The trick is not to choose the one style to use always, but to choose the best style for a particular integration opportunity. Each style has its advantages and disadvantages. Two

applications may integrate using multiple styles such that each point of integration takes advantage of the style that suits it best. Likewise, an application may use different styles to integrate with different applications, so as to choose the style that works best for the other application. Some integration approaches can best be viewed as a hybrid of multiple styles. An integration product or EAI middleware may employ a combination of styles, all of which are effectively hidden in the products implementation (13).

2.2 Enterprise Modeling

Enterprise modeling is an abstract concept hard to perceive. This section aims to provide definitions, reasons for modelling (why model?), background and the roles of Enterprise Modeling.

2.2.1 Definitions of Enterprise Modeling

There are several definitions of Enterprise Modeling:

- A computational representation of the structure, activities, processes, information, resources, people, behaviour, goals and constraints of a business, government, or other enterprise (16).
- Enterprise modeling is the set of activities or processes used to develop the various parts of an enterprise model to address some desired modeling finality (17).
- A collective name for the use of models in Enterprise Engineering and Enterprise Integration (17).

2.2.2 Why model?

Illustrate the roles that modeling could play in real world situations, using an example (18):

- To analyze a real world situation using simple modeling ideas.
- To illustrate how a simple model could help identify serious gaps in organizational processes and management.
- To highlight the roles a model could play.

2.2.3 Background of Enterprise modeling

Enterprises must become agile and integrated across their functions to remain competitive. Being agile implies that enterprises must be able to change or adapt easily. If there are changes, we need to be able to determine the impact of changes on all parts of the enterprise (17).

2.2.4 Role of an Enterprise Model

Towards supporting model-driven enterprise design, analysis and operation (17).

Perspectives	Examples
Design	An Enterprise Model should provide the language used to define an enterprise . It should support the possibility to explore alternative designs or models. Need to reason about alternative designs, e.g. can a process be performed in different ways? Can a goal be achieved in a different way?
Analysis	Need to be able to detect the impact of changes . E.g. how will the purchase of a machine affect the activities? How will changing the processes affect the resource consumption?
Operation	The Enterprise Model must be able to represent what is planned, what might happen and what has happened. It must supply the information necessary to support the operations of an enterprise.

Figure 2.3: Role of an Enterprise Model

2.3 Enterprise Architecture (EA)

This section aim to explain why, what, the role, motivation, concepts and methodologies for Enterprise Architecture (EA).

2.3.1 Why Enterprise Architecture?

Why Enterprise Architecture? 25 years ago, a new field was born that soon came to be known as enterprise architecture. The field initially began to address two problems (19):

- System complexity: Organizations were spending more and more money building and maintaining IT systems.
- Poor business/IT alignment: Organizations were finding it more and more difficult to keep those increasingly expensive IT systems aligned with business need.

The bottom line: more cost, less value.

2.3.2 What is Enterprise Architecture?

Enterprise Architecture (19):

- An enterprise: An organizational unit, from a department to a whole corporation.
- An architecture:
 - A formal description of a system, or a detailed plan of the system at component level to guide its implementation.

- The structure of components, their inter-relationships, and the principles and guidelines governing their design and evolution over time.
- A formal description of an enterprise, a detailed map of the enterprise at component level to guide its changes.
- The structure of an enterprises components, their interrelationships, and the principles and guidelines governing their design and evolution over time.

The Open Group definition (19): Enterprise Architecture is about understanding all of the different components that go to make up the enterprise and how those components inter-relate.

In the book Enterprise Architecture as a Strategy EA is defined as: Enterprise architecture is the organizing logic for business processes and IT infrastructure reflecting the integration and standardization requirements of the company’s operating model (20). Enterprise Architecture as a Strategy at its concepts will be studied further in section 2.6.

The Gartner definition: A planning discipline for the enterprise that goes beyond technology choices (19):

1. Driven by the strategic intent of the enterprise.
2. Holistic in breadth.
3. Designed to create a future state road map.
4. Provides flexibility and adaptability for changing business, information, and solution needs meaning change enabler.
5. A bridge between strategy and implementation.



Figure 2.4: EA a bridge between strategy and implementation

2.3.3 Why do an organization need an EA?

Why does an organization need an EA (19):

- The purpose of enterprise architecture is to optimize across the enterprise the often fragmented legacy of processes (both manual and automated) into an integrated environment that is responsive to change and supportive of the delivery of the business strategy.

- Thus the primary reason for developing an EA is to get an overview (map) of the business processes, systems, technology, structures and capabilities.
- The organization need an EA to provide a strategic context for the evolution of the IT system in response to the constantly changing needs of the business environment.
- The organization need an EA to achieve competitive advantage.

2.3.4 What to achieve with EA?

What to achieve with EA is a common understanding. And EA is about bridging the gap between Business and IT (19):

- Enhance the relationships between IT and the business
- Reinforce IT understanding of the business strategy
- Create a process for continuous IT/business alignment
- Enhance IT agility to support business changes
- Create business value from IT

2.3.5 Key Concepts of EA

Key Concepts of EA are (19):

- Stakeholders concerns: Interests that are critical or important to other stakeholders.
- Principles: A univocal understanding about what is of fundamental importance for the organization.
- Models: Purposeful abstractions of reality.
- Views: Difficult to make a univocal and comprehensive set of models that can be understood by all concerned, hence views.
- Frameworks: Structure to select views.

2.3.6 Methodologies for EA

Most popular methodologies for Enterprise Architecture (21):

1. The Zachman Framework for Enterprise Architecture.
2. The Open Group Architectural Framework (TOGAF).
3. The Federal Enterprise Architecture (FEA).
4. The Gartner Methodology

In this thesis the focus will be on the TOGAF methodology. The core concepts of TOGAF is described in Appendix D.

2.4 Governance

Governance refers to all processes of governing, whether undertaken by a government, market or network, whether over a family, tribe, formal or informal organization or territory and whether through laws, norms, power or language. It relates to the processes of interaction and decision-making among the actors involved in a collective problem that lead to the creation, reinforcement, or reproduction of social norms and institutions (22). This section aim to define following governance concepts: Corporate or Business Governance, EA Governance, IT Governance and SOA Governance.

2.4.1 Corporate and Business Governance

Corporate Governance is defined by The Organization for Economic Cooperation and Development's 1999 publication "OECD Principles for Corporate Governance," as providing the structure for determining organizational objectives and monitoring performance to ensure that objectives are attained (23). Business Governance is the set of processes, customs, policies, laws, and institutions affecting the way an organization is directed, administered, or controlled (26).

2.4.2 IT governance

IT governance is about: Specifying the decision rights and accountability framework to encourage desirable behavior in use of IT (23).

Effective IT Governance must address three questions (23):

1. What decisions must be made to ensure effective management of IT?
2. Who should make these decisions?
3. How will these decisions be made and monitored?

What decisions must be made and who should make them? Below are five key decisions illustrating Decision Domains (23):

- IT principles: Clarifying the business role of IT.
- IT architecture: Defining integration and standardization requirements.
- IT infrastructure: Determining shared enabling services.
- Business application needs: Specifying the business need for purchased or internally developed IT applications.
- IT investment and prioritization: Choosing which initiatives to fund and how much to spend.

	IT Principles		IT Infrastructure		IT Architecture		Business Applications*		IT prioritization and Investment	
	Input	Decision	Input	Decision	Input	Decision	Input	Decision	Input	Decision
Business Monarchy										
IT Monarchy										
Feudal										
Federal										
Duopoly										
Anarchy										

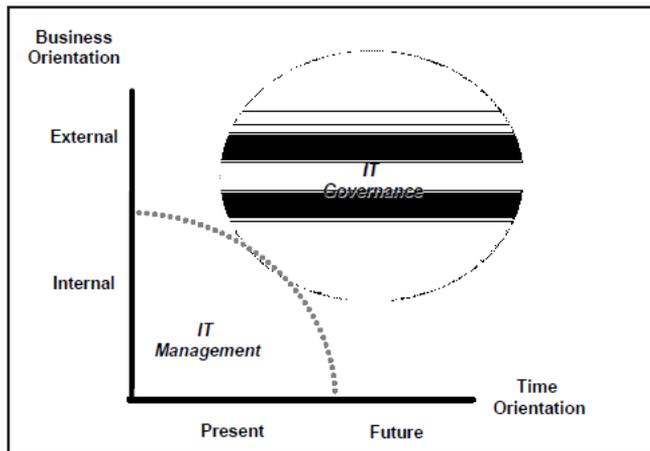
Figure 2.5: Decision Domains and Governance Archetypes

One or more people are responsible for making each of these decisions. Typically, many more people provide input to these decisions. IT Governance involves defining who will be responsible for both input and decision making for each decision. The row heading in figure above set a list of archetypes for specifying decision rights illustrating Governance Archetypes (23):

- Business monarchy: Top managers.
- IT monarchy: IT specialists.
- Feudal: Each business unit making independent decisions.
- Federal: Combination of the corporate center and the business units with or without IT people involved.
- IT duopoly: IT group and one other group (for example, top management or business unit leaders).
- Anarchy: Isolated or individual or small group decision making.

2.4.3 IT Governance vs. IT Management

IT Management is focused on the internal effective supply of IT services and products and the management of present IT operations. IT Governance in turn is much broader, and concentrates on performing and transforming IT to meet present and future demands of the business (internal focus) and the business customers (external focus) (24). This does not undermine the importance and complexity of IT management, but whereas elements of IT Management and the supply of (commodity) IT services and products can be commissioned to an external provider, IT Governance is organization specific, and direction and control over IT can not be delegated to the market (24; 25). See figure below.



Peterson (2003). Information Strategies and Tactics for Information Technology Governance. In W. Van Grembergen (Ed.), Strategies for Information Technology Governance. Hershey, PA: Idea Group Publishing.

Figure 2.6: IT Governance vs. IT Management

2.4.4 EA Governance

The Open Group SOA Governance Framework Technical Standard (26) defines Enterprise Architecture as: (EA) Governance is the practice and orientation by which enterprise architectures and other architectures are managed and controlled at an enterprise-wide level. The Open Group is a vendor-neutral and technology-neutral consortium, whose vision of Boundaryless Information Flow will enable access to integrated information within and between enterprises based on open standards and global interoperability (26).

2.4.5 SOA Governance

Service-oriented architecture (SOA) is a design pattern based on distinct pieces of software providing application functionality as services to other applications via a protocol. This

is known as service-orientation. It is independent of any vendor, product or technology (15). The Open Group defines Service-Oriented Architecture (SOA) as: An architectural style that supports service-orientation. Service-orientation is a way of thinking in terms of services and service-based development and the outcomes of services (15)

The Open Group SOA Governance Framework Technical Standard (26) defines SOA governance as: SOA governance should be viewed as the application of Business governance, IT governance, and EA governance to Service-Oriented Architecture (SOA). In effect, SOA governance extends IT and EA governance, ensuring that the benefits that SOA extols are met. This requires governing not only the execution aspects of SOA, but also the strategic planning activities (26). See figure below:

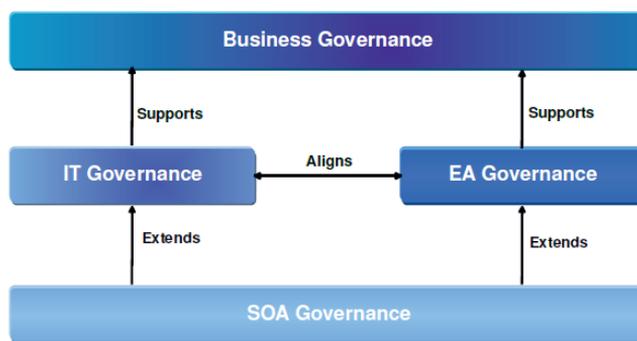


Figure 2.7: The SOA Open Group Governance Framework

2.5 Integration Governance

The concept integration Governance is defined in this section. Integration Governance is a further development of the concept SOA Open Group Governance Framework (See figure 2.7. above). It aims to provide a holistic view for integration concerns. Below I present the steps defining of the concept Integration Governance applied in this thesis.

2.5.1 Step1: Add integration options

SOA Governance mainly takes into account one integration option: Web-services or Remote Procedure Invocation. This explained in chapter 2.1.3 Integration options. At NTNU most integration options are applied (Appendix C) and at comparable organizations (Appendix B) several or all integration options are applied as well. The trick is not to choose one integration option to use always, but to choose the best integration option for a particular integration opportunity as explained in chapter 2.1.3 (13). Therefore, from my point of view, one should take into account all integration options defined, not just SOA as an integration Option. See figure below.

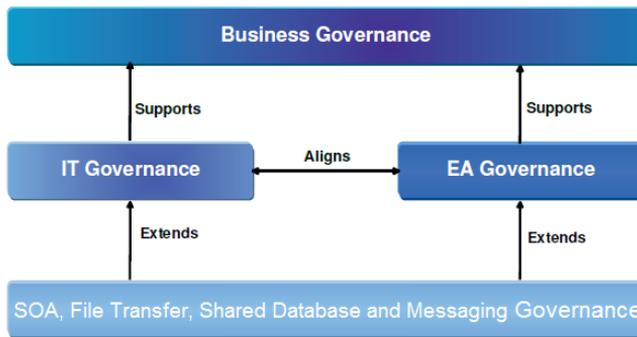


Figure 2.8: Step1: Add integration options

2.5.2 Step2: Add strategic, tactical and operational level

In addition integration concerns all horizontal levels of an information system explained in figure 2.2 (12). From my point of view this fact should be reflected from the execution (operational) aspects to the strategic planning activities (26). This represents a vertical view of integration concerns. Between the strategic and operational level there should be a level linking the strategic and operation level. I define this level as the tactical level. This to provide a link (red line) between the strategic and tactical level. See figure below.

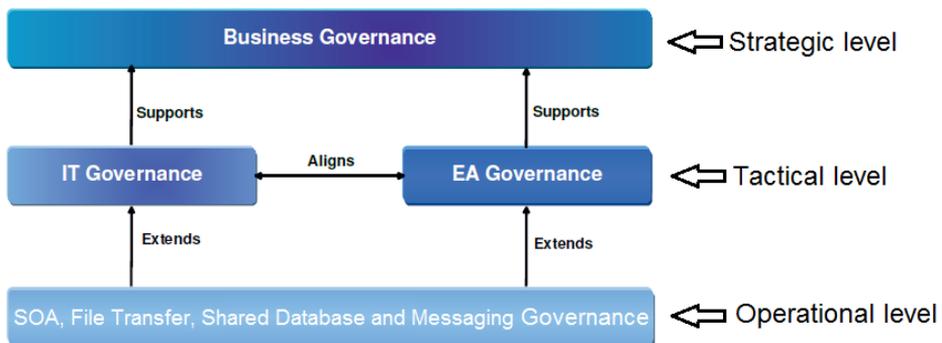


Figure 2.9: Step2: Add strategic, tactical and operational level

2.5.3 Step3: Integration Governance

Integration Governance concerns both the vertical and horizontal view concerning all integration options as well explained in chapter 2.1.3 (13). It is about providing a holistic view for integration governance at strategic, tactical and operational level (the vertical view) and horizontal integration explained in figure 2.2 (12) (the horizontal view). The figure below describes Integration Governance.

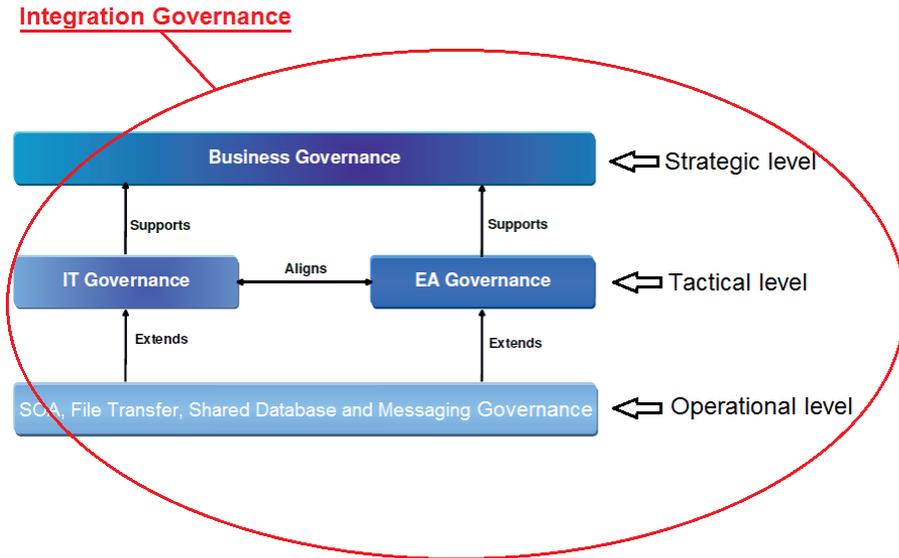


Figure 2.10: Step3: Integration Governance

2.6 Enterprise Architecture as a strategy

In this section important concepts from book the Enterprise Architecture as a Strategy (20) are presented. To understand the concepts it is important to start with an explanation of the level of analysis and research. Then this section presents the concept of The foundation of execution, the concept Operation model and the four types of Operation models.

2.6.1 Level of analysis and research

This subsection explains the level of analysis and research important to understand the concepts from the book Enterprise Architecture as a Strategy (20):

- It is now clear our problem was the level of analysis. As Albert Einstein famously remarked, "The significant problems we face cannot be solved by the same level of thinking that created them."
- The problem with our efforts to understand IT architecture was that the level of analysis was all wrong. The focus needs to be higher on enterprise architecture, the organizing logic for core business processes and IT infrastructure reflecting the standardization and integration of a company's operating model.
- The insights in the book come from a series of research projects exploring enterprise architecture in more than 200 companies (and another 256 companies where our focus was on IT governance) from 1995 to 2005. Most of the research was done at the MIT Sloan School's Center for Information Systems Research (CISR)

2.6.2 Foundation of execution

To Execute Your Strategy, First Build Your Foundation. Some companies or enterprises (20):

- Have more-productive employees.
- Get more from their investments.
- Have more success with their strategic initiatives.

What are they doing differently?

Foundation of execution is (20):

- The IT infrastructure.
- The digitized business processes automating a company's core capabilities.

Paradoxically, digitizing core business processes makes the individual processes less flexible while making a company more agile. Analogy: A great athlete will have muscles, reflexes, and skills that are not easily changed. But these capabilities give athletes a tremendous ability? React, improvise, and innovate in their chosen sport. Similarly, digitizing business

processes requires making clear decisions about what capabilities are needed to succeed. Once these new processes are installed, they free up management attention from fighting fires on lower value activities, giving them more time to focus on how to increase profits and growth. Digitized processes also provide better information on customers and product sales, providing ideas for new products and services. The foundation for execution provides a platform for innovation (20).

Motivation: Do you have a good foundation for execution?

The warning signs listed below (20) should be a motivation to consider the foundation for execution:

- Different parts of our company give different answers to the same customer questions.
- Meeting a new regulatory or reporting requirement is a major effort for us, requiring a concerted push from the top and Significant infrastructure investment.
- Our business lacks agility-every new strategic initiative like starting from scratch.
- IT is consistently a bottleneck.
- There are different business processes completing the same activity across the company, each with a different system.
- Information needed to make key product and customer decisions is not available.
- A significant part of people's jobs is to take data from one set of systems, manipulate it, and enter it into other systems.
- Senior management dreads discussing IT agenda items.
- We don't know whether our company gets good value from IT.

How do you build a foundation for execution?

Companies must master three key disciplines (20):

- *Operating model.* The operating model is the necessary level of business process integration and standardization for delivering goods and services to customers.
- *Enterprise architecture.* The enterprise architecture is the organizing logic for business processes and IT infrastructure, reflecting the integration and standardization requirements of the company's operating model. The enterprise architecture provides a long-term view of a company's processes, systems, and technologies so that individual projects can build capabilities-not just fulfill immediate needs.
- *IT engagement model.* The IT engagement model is the system of governance mechanisms that ensure business and IT projects achieve both local and companywide objectives. (See section 2.4.2 IT-Governance)

Why is a foundation for execution important?

- The research found that companies with a solid foundation had higher profitability, faster time to market, and lower IT costs (20).
- These outcomes are universally beneficial and timeless-they were valuable twenty years ago and will be just as valuable twenty years from now (20).
- Companies without a solid foundation face a number of serious risks that weren't present just ten years ago (20).

2.6.3 Define Your operating model

- Integration and Standardization (20):
Key Dimensions of an Operating Model
- *Standardization* of business processes and related systems means defining exactly how a process will be executed regardless of who is performing the process or where it is completed.
- *Integration* links the efforts of organizational units through shared data. This sharing of data can be between processes to enable end-to-end transaction processing, or across processes to allow the company to present a single face to customers.

2.6.4 Four types of operating models

There are four general types of operating models (20). See figure 2.11 below.

1. Diversification (low standardization, low integration)
2. Coordination (low standardization, high integration)
3. Replication (high standardization, low integration)
4. Unification (high standardization, high integration)

2.6.5 The Four Stages of Architecture Maturity

To reach the Unification level Enterprise Architecture as Strategy introduce four stages for architecture maturity (20, p. 71):

1. *Business Silos architecture*
2. *Standardized Technology architecture*
3. *Optimized Core architecture*
4. *Business Modularity architecture*

Integration Governance best practice survey

An important part of the assignment (2) is to research best practice for integration governance at comparable enterprises. To conduct a Integration Governance best practice survey, a well reasoned questionnaire must be composed. This chapter describes the reasoning behind the questionnaire and how it is composed.

3.1 Composition of Survey

The composition of the survey is based in the definition of Integration Governance in chapter two. See figure below. The questions in the survey are classified in three levels:

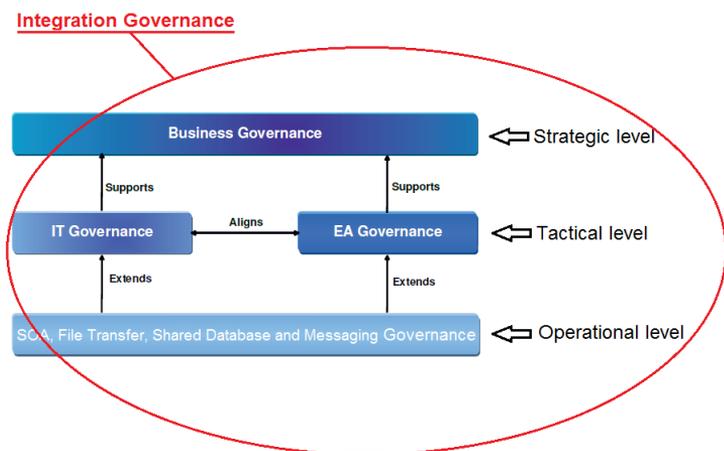


Figure 3.1: Integration Governance

3.2.2 Tactical level

At the tactical level questions are derived from the Open Group SOA Governance Framework Technical Standard (26), the assignment given from NTNU IT Division (2) and the Statoil Governance Document: IT Components (27) (Appendix M). The tactical level of questions aim to find best practice at the tactical level of the enterprise studied.

3.2.3 Operational level

At operational level questions are derived from Statoil Governance Document: It Components (27) and the assignment given from NTNU IT Division (2) The operational level of questions aim to find best practice at operational level of the enterprises studied.

3.3 The Questionnaire

The questionnaire is presented in Appendix A. When counting the number of questions classified at each level there are 15 questions at strategic level, 51 questions at tactical level and 21 questions at operational level. There are 87 questions in total. Before reaching 87 questions, there was a test/development period of the questionnaire. Two test surveys were conducted (Appendix C). The initial version of the questionnaire was first tested on two NTNU IT Architects (35; 36). The test surveys were conducted by face to face interviews. After the test surveys the questionnaire was supplemented. The first ordinary survey conducted was at UIO/USIT (Appendix B) by face to face interview. I learned that some questions were missing at strategic level. Questions at strategic level were then added and the questionnaire was complete.

3.4 Surveys conducted

There are 12 surveys conducted. External surveys were conducted interviewing 7 comparable enterprises: Statkraft, Hemit, Sykehuspartner (Integrasjonsfabrikken), a bank, a large commercial IT service/infrastructure supplier, Statoil and the University of Oslo (UIO). Comparable enterprises means relative large enterprises having concerns about integrations. And internal NTNU surveys were conducted interviewing 5 roles at NTNU having concerns about integrations: The NTNU Organization Director, NTNU IT-Director, NTNU IT Section Manager and two NTNU IT Architects.

Integration Governance best practice analysis

This chapter presents the best practice analysis for the surveys conducted. The surveys are based on Questionnaire described in Appendix A. A goal is not only to get knowledge of best practice, but some general principles.

4.1 Quantitative and Qualitative approach

The interviewee's hold various positions in their respective enterprises. Most answers in the survey are textual and will vary the in given context of the enterprise investigated and the interviewee's position in the enterprise. Therefore the analysis will have a qualitative approach. It makes sense that their answers will variate after their context and perspectives in given positions. However, they have a common responsibility in integration, at different levels in their respective organizations. The accuracy of answers may vary as it was difficult for the interviewee to define the relevant context for the questions answered. For external surveys answers are given in Appendix B. And for internal NTNU surveys answers are given in Appendix C.

In the section "Enterprise operation model categorization" I will categorize the enterprises by degree of business process standardization and business process integration attempting to determine the operation model of the enterprise (20). This attempt to categorize the enterprises operation model at strategic level.

In the section "Best practice?" a quantitative analysis approach is applied attempting to discover whether best the practice enterprises at strategic level (figure 4.1) actually holds best practice at tactical and operational level as well.

The section "Best practice analysis summary" attempt to extract best practice and

knowledge found in the surveys and analysis in some general principles. Finally there is the last section in this chapter: Evaluation of surveys and analysis.

4.2 Enterprise operation model categorization

Enterprises categorization are based on surveys (Appendix A) at strategic level. See figure 4.1 below. The enterprise categorization is based on question 1 to 8a in the questionnaire (Appendix A, strategic level). In particular question 8a and 8b ask how the degree of business process integration and business process standardization is perceived by the interviewee. The interviewees answers make it possible to determine the respective enterprise operation model. The figure below aim to categorize the enterprises operation model based on best practice surveys conducted.

Characteristics of four operation models

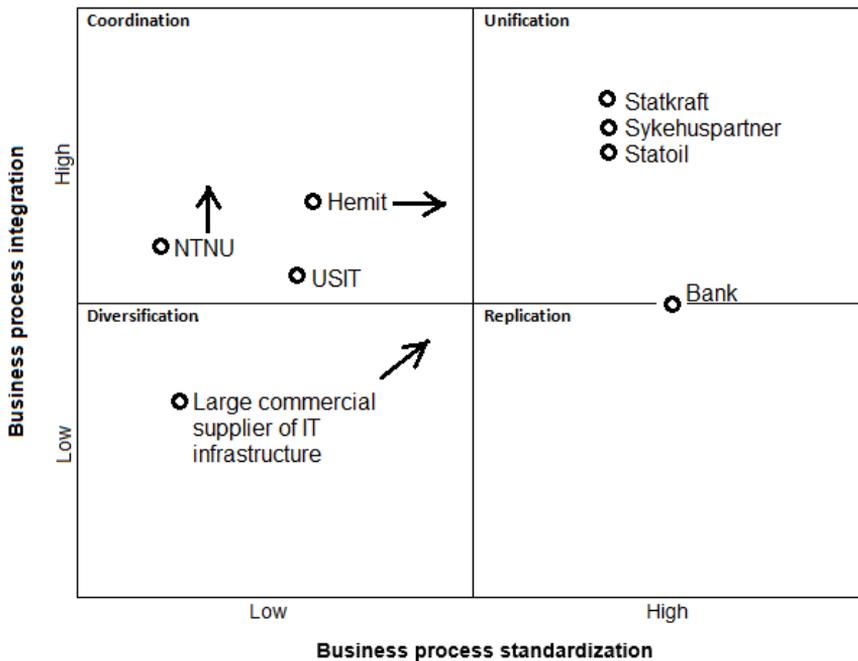


Figure 4.1: Enterprise operation model categorization

In the figure above there are some arrows attached to enterprises. It indicates a goal for the enterprise to change in that direction. NTNU is investing in integration projects, however the potential of the investments are not yet realized (28). (In Appendix C there are data from 5 NTNU surveys. The survey from the section manager NTNU IT Division (28) was plotted in figure 4.1 because it is complete). Hemit have started work on standardization

and are moving in that direction (29). And the large supplier of IT infrastructure is working determinedly towards improved integration and standardization (30). Studying the answers for the bank IT-operations in the survey it is not easy to determine the operation model (31). However, based on the answers the survey, I categorize bank IT-operations model between Unification and Replication.

4.3 Best practice?

In figure 4.1 above there are three enterprises in the Unification operation model box. These enterprises are by the figure 4.1. defined to have the best practice. The plotting of figure 4.1 is based on the interviewees subjective perception regarding their enterprise in the surveys. How can I assume that three enterprises in the Unification operation model box actually holds a best practice?

To verify best practice. Each question in the survey is scored (Appendix B and Appendix C). The score indicates if the question asked represent an actual practice. The answers are scored like this:

- 1 point: The answer represents an actual practice.
- 0,5 point: The answer represents a partly or incomplete actual practice.
- 0 point: The question is not answered or irrelevant.

The score is for each enterprise in the survey summarized at strategic, tactical and operational level. See table below. Note the table Survey score (Table 4.1) does not tell anything

Enterprise/statistics	Strategic	Tactical	Operational	Total score
Sykehuspartner	15	50,5	20	85,5
Statoil	15	49,5	18	82,5
Statkraft	15	42	20	77
Hemit	15	41	19	75
Bank	11	41	18,5	70,5
IT supplier	15	33	17	65
NTNU	13	33	17,5	63,5
USIT/UIO	13	30,5	14,5	58
Number of questions	15	51	21	87
Average score	14,00	40,06	18,06	72,13
Standard deviation	1,41	7,02	1,69	8,99

Table 4.1: Survey score

about a best practice. The table give score whether there is a actual practice for the questions given at strategic, tactical and operational level. In the table above the three

enterprises with the highest score is respectively Sykehuspartner, Statoil and Statkraft. These enterprises are the same plotted in the Unification Box, figure 4.1. These enterprises actually have the highest score at each level. (Exception is Statoil at operational level.) This indicates there is a correlation of best practice between the strategic, tactical and operational level.

Their answers (Sykehuspartner, Statoil and Statkraft) in the surveys at strategic, tactical and operational level will be the basis for best practice for Integration Governance. Based on the surveys I may assume these three enterprises are the most competitive and agile, thereby having the best practice studied. The best practice three enterprises: Statoil, Statkraft and Sykehuspartner is studied and compared further in Appendix D. In table 4.1 the standard deviation for operational level is relative low. This indicates that practice at operational level is sound with little variation.

4.4 Qualitative analysis

Qualitative analysis is described in Appendix E. Qualitative analysis is based on best practice comparison described in Appendix D. In addition in the Qualitative analysis of best practice enterprises there are some interesting practices worth notice from other enterprises in the survey as well (Appendix B). These are marked: Interesting practice in the Qualitative analysis (Appendix E). Please note the Qualitative analysis will be colored by my personal point of view.

4.5 Best practice analysis summary

Surveys are conducted and analysis at strategic, tactical and operational level. There are 12 surveys conducted. 5 internal NTNU surveys. 7 External surveys from external enterprises. 7 external surveys do not provide a sufficient statistical basis for a quantitative analysis. Therefore the Qualitative analysis (Appendix E) is the basis for the analysis of Integration Governance best practice summarized. This is a subjective assessment colored by my personal experience and knowledge.

Integration Governance best practice can be summarized to following rules and principles for an enterprise:

1. *Enhance business process standardization and integration (20) when appropriate.*
2. *Strategy and vision for the enterprise and IT anchored:*
This with a red line from strategy to operations. I think the red line is a defined IT-governance model and an enterprise architecture. (Indication described in chapter 4.3 above: "correlation of best practice between the strategic, tactical and operational level.")
3. *Implement ITIL framework*
Appendix F

4. *Architecture frameworks as TOGAF are either implemented or TOGAF guidelines are applied:* Frameworks should be adapted to the existing organization (32) Architectural guidelines should be described in governance documents.
5. *The line or business side should own the processes and data (32; 33):*
Ownership should be clearly defined in e.g. governance documents.
6. *There should be a forum where data and process owners interact:*
Examples are: The Statkraft priority board, Statoil IT-arena (38, p. 38) and Statoil product owner arena (32). Responsibility and delegated authority (decision model) should be defined in governance documents. This may be handled in a forum of excellence as implemented at Sykehuspartner (33).
7. *Architectural guidelines should be defined in governance documents:*
A project or team can define detailed architectural principles based on guidelines. Having guidelines described in governance document and detailed integration principles defined at a lower level make it possible to avoid conflicts concerning architecture perceptions (32). A breach of architectural guidelines must be reasoned (27).
8. *Decisions must follow guidelines and defined IT-Governance structure (engagement model):*
Decisions can be made at lowest possible level (32; 34). This unless it interferes with degree of standardization and follows defined IT-Governance structure.
9. *The IT system shall not pass the border for the business process:*
An important principle is: Information borders and process borders shall follow each other (27).
10. *Describe information models and master data models for the most important information objects (32).*

Enterprises in the unification operation model (See figure 4.1) tends to have a more established practice for governance and enterprise architecture than the other enterprises in the survey. This based by score and standard deviation in table 4.1

Appendix D provide a comparison of the three best Integration Governance practices. It might be interesting for the reader to analyze and compare the enterprises with the best practice. What is similar and what is different?

4.6 Evaluation of surveys and analysis

The questions for the survey were developed based on The Open Group Technical framework, Statoil Governance document "IT Components" (27), the Enterprise Architecture as a Strategy (20) presented in chapter 2.6. and the assignment given from the NTNU IT Division (2). Before conducting the surveys I was anxious as to whether the questions would be perceived as relevant. Therefore I asked two colleagues if they could act as test interviewees (35; 36). After initial test interviews some questions were added and adjusted.

12 surveys were conducted between 24. of October and 15. December 2014. 7 external enterprises were examined through interviews. 5 NTNU interviews were conducted. All interviews were face to face interviews except interview with Hemit (Lynx). 3 interviews were recorded. The recorded interviews are more detailed. The interview conducted by Lynx connection might have made room for some misunderstandings.

During the first part, strategic level, of the interviews conducted I experienced some difficulties with the interviewees setting the context for their respective enterprises. E.g: For the question 1. Do the enterprise have shared customers and suppliers? It could be hard for the interviewee to define what is their customers and suppliers. It depends on the interviewees position in the enterprise and type of enterprise. After a short discussion the context for interviewee were settled. Still it is possible that there were some misunderstandings reasoned by unknown people, unknown enterprise culture and perhaps tacit knowledge. Also this is a thorough survey with 87 questions in total. There are many questions for the interviewee to respond to in a short time and one might get tired.

The interviewees hold positions at different levels in their organizations. Therefore they probably have different perspectives. What they have in common is a responsibility for integration. Different perceptions from different positions might visualize a more holistic view. All interviewees representing the 7 external enterprises were asked if the questions were relevant. All of interviewees answered the questions were relevant, with some variance depending on strategic, tactical or operational level (See Appendix B).

Chapter 5

NTNU practice: Enterprise Architecture and IT-governance

NTNU, Enterprise Architecture, IT-strategy, IT-governance and IT-operation Previous chapter stated a best practice for Integration Governance. To be able to improve Integration Governance at NTNU I must explain NTNU's organization, strategy, enterprise architecture, IT strategy, project portfolio, governing concepts and IT-operations as is. This chapter will be based on information from the NTNU web, NTNU internal documents and the 5 NTNU internal surveys listed in appendix A.

5.1 NTNU organization and strategy

This section presents NTNU strategy and organization.

5.1.1 NTNU strategy 2011-2020

Vision: Knowledge for a better world

"NTNU aims to create the basis for the development of knowledge and to create value economic, cultural and social. We will make the best possible use of our main profile in science and technology, our academic breadth, and our interdisciplinary expertise to tackle the large and complex challenges faced by Norway and the world community " (39).

5.1.2 Organization

The Norwegian University of Science and Technology (NTNU) is Norway's primary institution for educating the nation's future engineers and scientists. The university also has strong programmes in the social sciences, teacher education, the arts and humanities, medicine, architecture and fine art (2). The university has 48 departments organized in 7 faculties and

a central administration. There are about 23000 students and 5000 employees at NTNU. The figure below describes the NTNU organization (40).

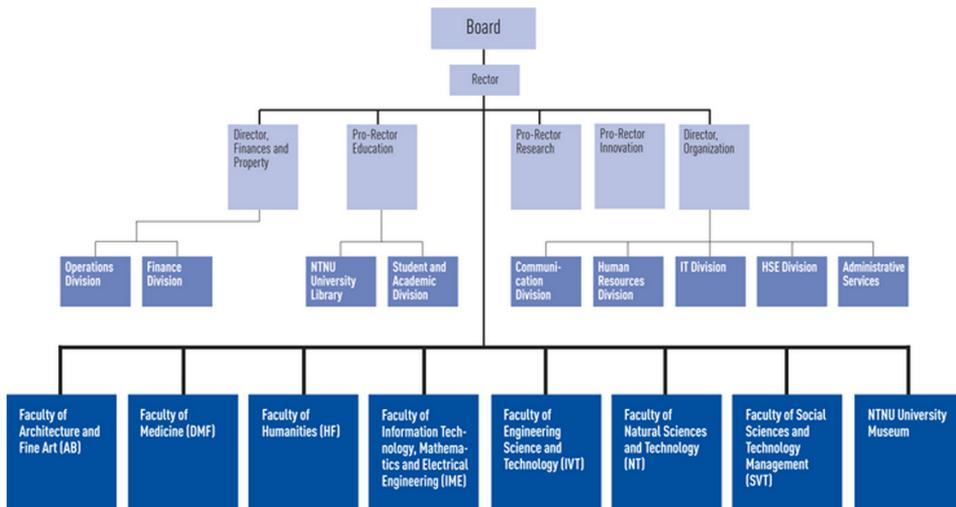


Figure 5.1: NTNU Organization

5.2 NTNU Enterprise Architecture and Enterprise model

NTNU Enterprise Architecture and Enterprise model is the responsibility of the NTNU IT-Division. The architecture function has three main areas of focus (41):

1. Information security and data protection
2. IT infrastructure and platform
3. Enterprise architecture, IT solutions and applications

The IT architects at NTNU are mainly advisers regarding issues related to ICT-architecture regarding (41):

- IT strategy
- IT procurement
- IT development projects
- Enterprise architecture for NTNU
- Day to day operations regarding non-functional requirements such as legislation, public requirements, local business requirements at NTNU and NTNU strategy.

The figure below displays a sketch of an Enterprise model at NTNU where ICT-services support the most important focus areas at NTNU: Research, education, innovation, and communication (41). The architecture is described in the document: ICT Target Picture for NTNU (42).

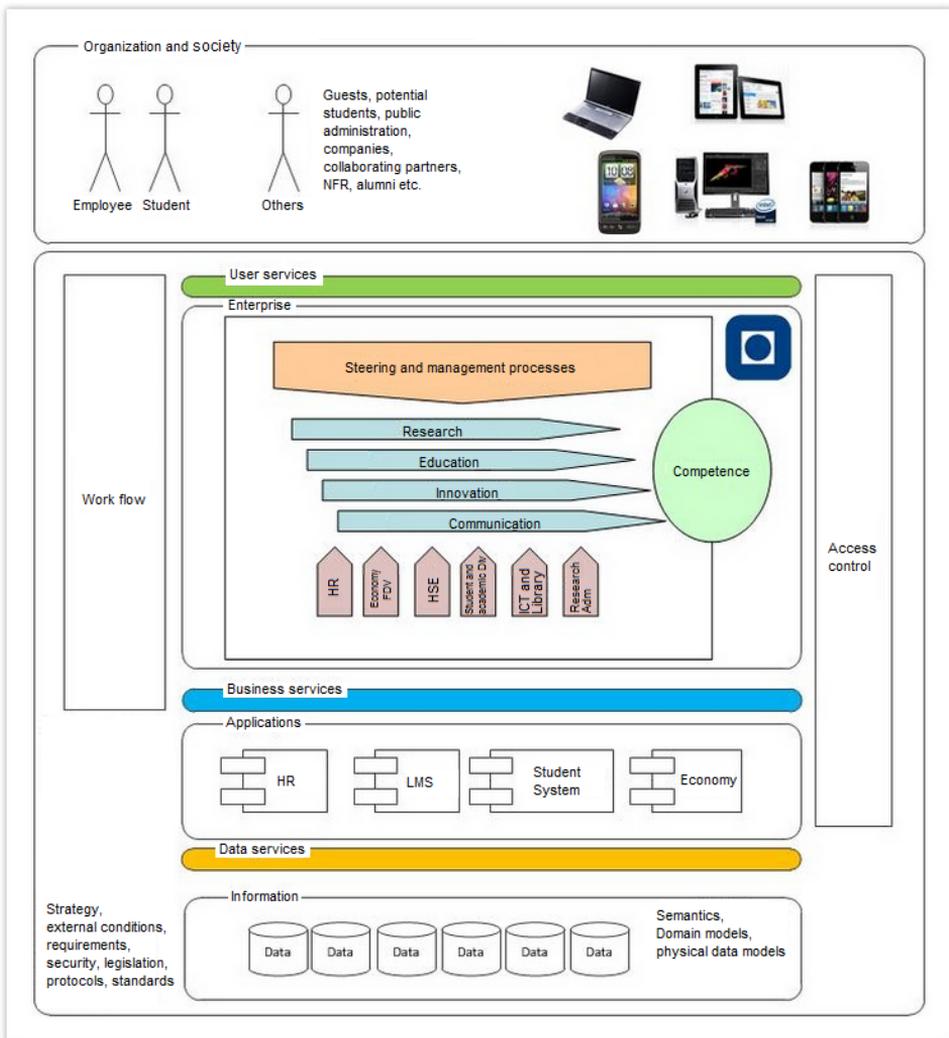


Figure 5.2: Sketch of NTNU Enterprise Model

The IT-architects at NTNU IT-Division primarily apply a TOGAF (45) approach (Appendix F) for the architectural work. In the Norwegian public sector DIFI (43) describe the use of architectural frameworks in an enterprise context. At the NTNU IT-Division PAM (44) is applied as the method for project execution including architecture processes. PAM includes a process for securing and communicating lessons learned from each project (44).

It is worth noting the IT-architecture work at NTNU in a TOGAF perspective is far from complete. Reason for this is that the IT-architect function is understaffed. The IT-architects use most of their resources on processing prospects from customers, stakeholders and supporting ongoing projects. Therefore architectural work as documenting and collecting the architecture and designing target pictures is not prioritized (46). Meaning a TOGAF Architecture Repository (45) is lacking. The architects would have great use for target pictures for processing the most usual prospects related related to (42):

- TIA/SOA
- IAM
- Data storage
- Client equipment
- Security

5.3 NTNU IT-strategy

Strategy for for NTNU IT-Division from 2013 to 2017 (47):

NTNU IT vision:

- Knowledge for a better world - IT for a better university

Role of NTNU IT:

- NTNU IT is the main supplier of the future IT-services at NTNU

5.4 NTNU IT-governance

This section explain the practice for IT-governance at NTNU. It is based on interviews with managers and IT-architects at NTNU (Appendix A) and the document: "NTNU IT-governance model - evaluation and need for change 2013" (48). The principles behind the current IT-governance model were approved by the NTNU board in 2006. However the intentions for the model has not been realized and some adjustment of the IT-governance model might be required (48).

After the the report (48) was delivered the IT-governance model was changed. A new model describe how IT-decisions can be made at NTNU top level involving top level managers as Director of Finance and Property, IT-Director and Director of Organization. IT-decisions has been reorganized and is on track (49). This top level management team has the temporary name: "The IT-board". Also there is the IT Operations committee doing some IT governance related work (50). In addition there is the Process committee (48). Still there is no target IT-governance model described (Appendix A) and there is no IT-governance documents describing how IT-decisions are made, except for the IT-governance model approved by the NTNU board in 2006. There is a practice for the IT-governance (46), however there is not clear and complete engagement model as described

in chapter 2.6.

There is a IT-decision model implemented. "This is really a very lite governance model derived from Gartner. It does not yet have a complete scope. It is the project portfolio in the central administration." (50). Actual governance practice is a lite governance model and governance by the IT project and project folio (50). The next section provide an overview over NTNU IT program portfolio.

5.4.1 NTNU program portfolio

This subsection describes the 2015 NTNU IT-program portfolio (51):

- **Basis IT II:** Program for Basis IT part 2, shall develop and increase the efficiency of the NTNU Infrastructure and common basis IT services in such a way that the enterprise can utilize IT at maximum advantage both as a strategic instrument and as a support function. Program owner: Haakon Alstad, CIO, NTNU IT Division
- **IT in education:** Program for IT in education, shall provide consistent and modern IT solutions for the students providing increased learning and support in the students work day. Program owner: Inge Fottland, Division Director, NTNU Student and Academic Division.
- **IT in the enterprise:** Program for IT in the enterprise, shall contribute to IT-tools for NTNU employees supporting the most applied processes in the enterprise area in a uniform manner. Program owner: Aud Magna Gabrielsen, Division Director, NTNU Financial Division.

Please note that two of the programs above are are owned by the business side and line organization.

5.4.2 NTNU Management regulations

Many issues regarding the practice of IT-governance at NTNU are determined by the NTNU management regulations (52) and the NTNU IT regulations (53).

5.5 NTNU IT-operations

This section explains the practice of IT operations at the NTNU IT Division. It is based on interviews with managers and IT-architects at NTNU (Appendix A). The NTNU IT operation processes are derived from the ITIL framework: Information Technology Infrastructure Library is a set of practices for IT service management (ITSM) that focuses on aligning IT services with the needs of business (54) The NTNU IT Division has implemented following ITIL processes: Servicedesk, Change management, Incident management, Problem management, Service level management and Security. For further description the NTNU IT ITIL processes see Appendix F.

Chapter 6

TIA case

This chapter describe the TIA case in which is given by the problem definition in chapter 1: Study TIA Case. Focus on FS, Common Student System. TIA is implementation of Service Oriented Architecture, SOA (15) at NTNU. TIA means service oriented information architecture. It is also required from the problem definition to focus on FS, the Common Student System. FS (56) is perhaps the most business-critical system for NTNU managing study administration processes such as: Admission, students, subjects, study programs, exams and more.

6.1 Purpose of TIA

TIA means service oriented information architecture and is an architecture project. The purpose of TIA is to improve data flow at NTNU. The figure below display the system architecture for TIA (7):

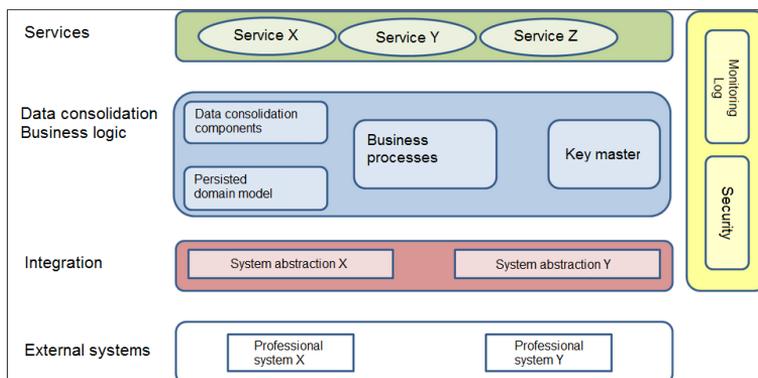


Figure 6.1: TIA system architecture

This implies implementation of a basis architecture which efficiently links new data sources to TIA and makes the data from the source available for TIA. Available data can be used to implement new services. TIA abstract data source dependencies giving room for standardization of the data source interface (57).

6.1.1 TIA development

After two years development TIA was set in production in December 2013 (68). The total cost of developing TIA was about 12 NOK million (68). The new TIA Technology should be able to meet "Time to market" requirements (7). In September 2014 the NTNU IT-Division launched an new NTNU parking app for Iphone and Android developed by an external supplier. TIA was applied as the integration platform. Developing integrations for the new parking app for Iphone and Android took less than 2 days. The new TIA integration platform had proved to be a large improvement compared with legacy integration platform. (55).

6.1.2 TIA and governance

With TIA the technical foundation for integration at NTNU is improved more flexible and providing products with shorter time to market. Issues regarding Governance for TIA-services where raised in TIA Architecture end report (7). The fundamental problems concerning governance related to stakeholders (61), data owners and process owners where partly raised in the TIA project (59), but not handled. This master thesis and assignment aim to improve governance concerning integration.

6.2 FS, Common Student System

The Common Student System, FS (56) is perhaps the most business-critical system for NTNU managing study administration processes as: Admission, students, subjects, study programs, exams and more. FS consist of many applications (62). See figure below:

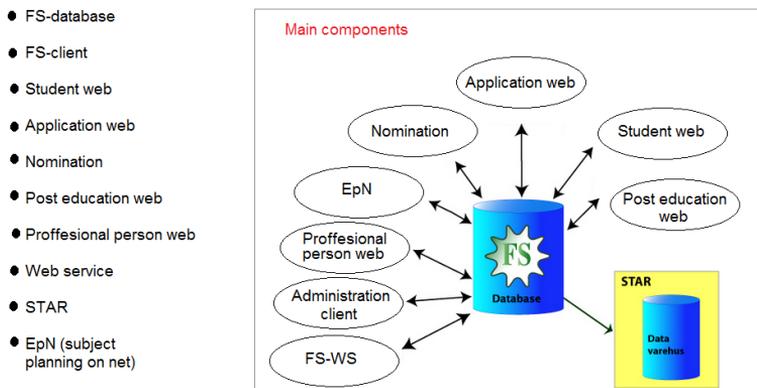


Figure 6.2: FS applications

6.2.1 FS data and NTNU data flow

The FS database consist of data critical for NTNU as an enterprise. The most important information objects in FS are integrated with data from other business critical systems at NTNU. The figure below (63) illustrates how data from business critical systems such as FS flow through the old/legacy integration system (Kjernen) to other enterprise services as e.g. Cognos Business Intelligence Service.

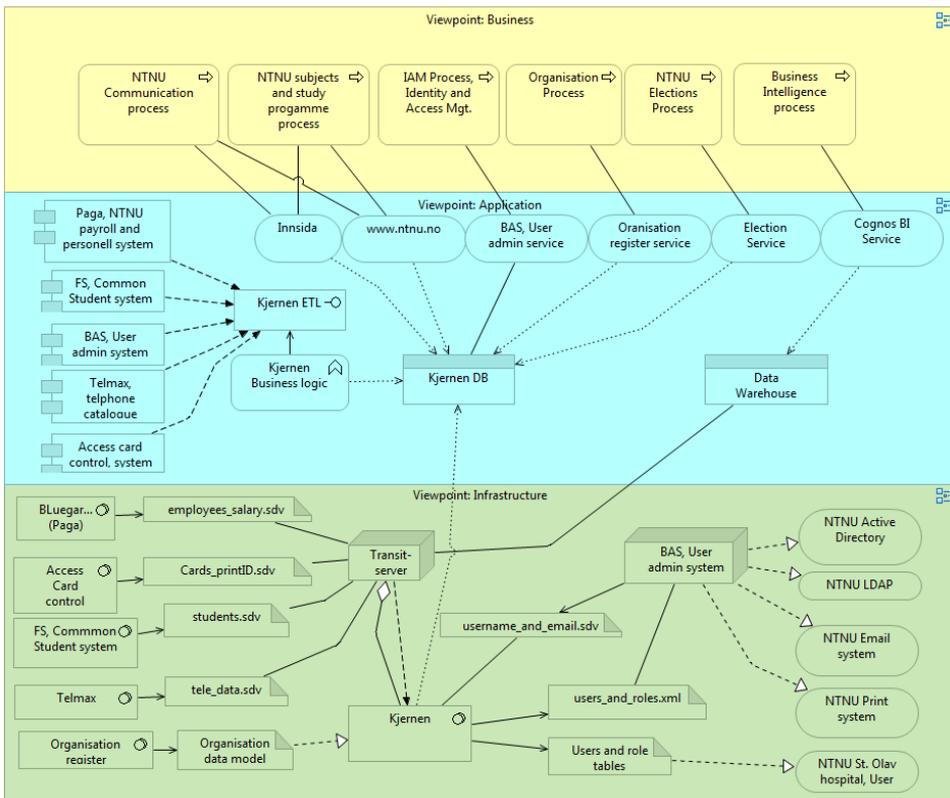


Figure 6.3: NTNU enterprise data flow (legacy)

6.3 Bevisst, Business Intelligence project

Bevisst is a Norwegian acronym for "better enterprise performance management". It is a large project for improving business intelligence and performance management at NTNU. The goals for Bevisst are (64):

- Improved process support for planning, budget and follow-up process at NTNU
- Managers at all levels at NTNU will be able to more easily access relevant information regarding their enterprise.

- NTNU will have more focus on data quality and thereby a basis for continuous data quality improvement.
- NTNU will have a foundation for further development and analysis of its enterprise through improved data availability.

6.4 FS, TIA and Bevisst

TIA is defined as the new integration platform and will provide data from FS to Bevisst (57). To ensure good data quality from FS to Bevisst one must first ensure good data quality in FS (64). If people and departments at NTNU have different processes and perception of context of data it will affect the overall data quality at NTNU. An analogy would be having apples, pears and bananas in the calculation. In primary school we learned that we cannot add apples, pears and bananas. To ensure good data quality the most important information objects must be perceived in the same way. "The key to process integration from a process perspective is data standardization-providing a single definition and a single set of characteristics to be captured with a data element" (23, p. 31). Information objects should be described as concepts and models in a standard manner. This description of information objects, concepts for individual things such as student and buildings, is usually called an Information Model (65).

6.4.1 Information model

I have chosen to focus on the most important information objects in FS and create a very narrow information model using information objects:

- Organization Unit
- Person
- Study program
- Course

Describing an information model for most important information objects aim to improve data quality and enhance standardization at NTNU. This information model will be a part of the enterprise model and architecture To-Be (Chapter 8) described in this assignment and thesis.

6.5 TIA roadmap

This section aim to provide a roadmap and overview over TIA and Information Architecture related projects. There are four relevant NTNU projects:

- Kjernen system (The Core)
- TIA project
- TIA2 project
- Service Structure Improvement project

Kjernen is the legacy integration system (6). The TIA project is the platform or framework for the new Service Oriented Information Architecture (59). The TIA2 project is architecture improvement and actual service deliveries (60). By applying TIA further the Service Structure Improvement Project has a goal to standardize the Information Architecture (66) and replace legacy. The legacy system and TIA2 represents an architecture model As-Is while the Service Structure Improvement Project represents an architecture model To-Be. The roadmap is displayed in the figure below.

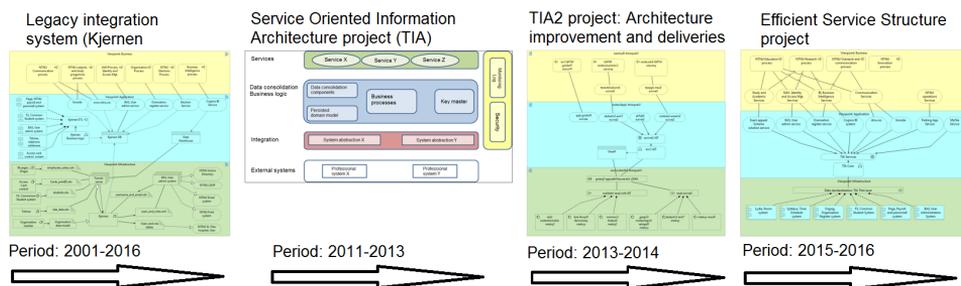


Figure 6.4: TIA Roadmap

Architecture model As-Is and architecture model To-Be is explained further in the next chapter.

TOGAF Analysis Scope

This Chapter defines Scope for TOGAF Analysis. The scope defines what to model in the following chapter Enterprise Model and Architecture supported by TOGAF. First this chapter describes TOGAF analysis scope input. Second this chapter presents TOGAF, The Open Group Architecture Framework and the Architectural Development Method (ADM). Third this chapter presents conceptual modelling As-Is and To-Be. Then the scope for enterprise model and architecture As-Is (EA As-Is) will be presented. Finally this chapter presents the scope for enterprise model and architecture To-Be (EA To-Be).

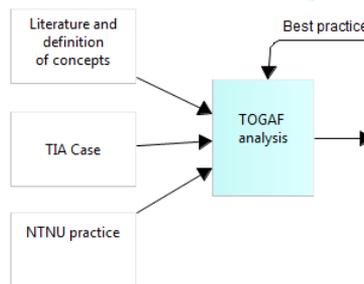


Figure 7.1: Research method: TOGAF Analysis Scope input

7.1 TOGAF Analysis Scope input

This section describes the input for TOGAF Analysis Scope. See figure 7.1 above.

1. Input: Best practice principles are described in chapter 4.5: "Best practice analysis summary"
2. Input: Actual NTNU practice is described in chapter 5: "NTNU practice: Enterprise Architecture and IT-governance"

3. Input: Literature and definition of concepts are described in chapter 2: "Definition of concepts"
4. Input: TIA Case is described in chapter 6: "TIA Case".

7.2 What is TOGAF?

TOGAF is an architecture framework. TOGAF provides the methods and tools for assisting in the acceptance, production, use, and maintenance of an enterprise architecture. It is based on an iterative process model supported by best practices and a re-usable set of existing architecture assets (45). Core concepts of TOGAF is further described in Appendix F.

7.3 TOGAF Framework or Process?

- TOGAF describes itself as a Framework. But the most important part of it is the Architectural Development Method (ADM) (67):
 - ADM is a recipe for creating architecture.
- TOGAF is an architectural process (21)

Below is a figure describing Architectural Development Method (ADM):

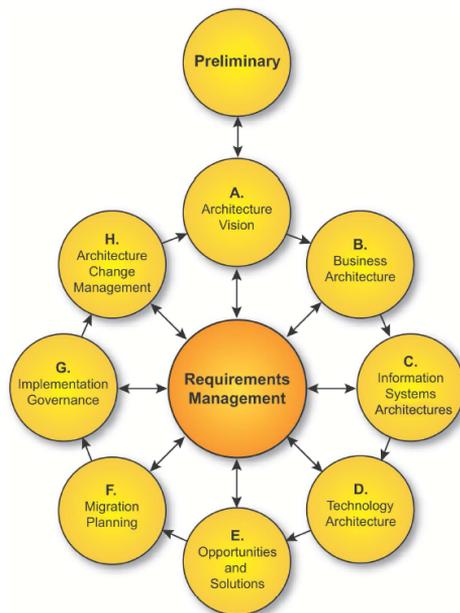


Figure 7.2: Architectural Development Method (ADM)

7.4 Conceptual modelling As-Is and To-Be

Application of conceptual modelling (69, p. 11). See figure 7.1 (Fig. 1.3) below "Abstractly as illustrated in Fig. 1.3, one can look upon an organisation and its information system to be in a current state (often looked upon as a descriptive as-is) that are to be evolved to some future wanted state (often looked upon as a prescriptive to be)" (69, p. 10).

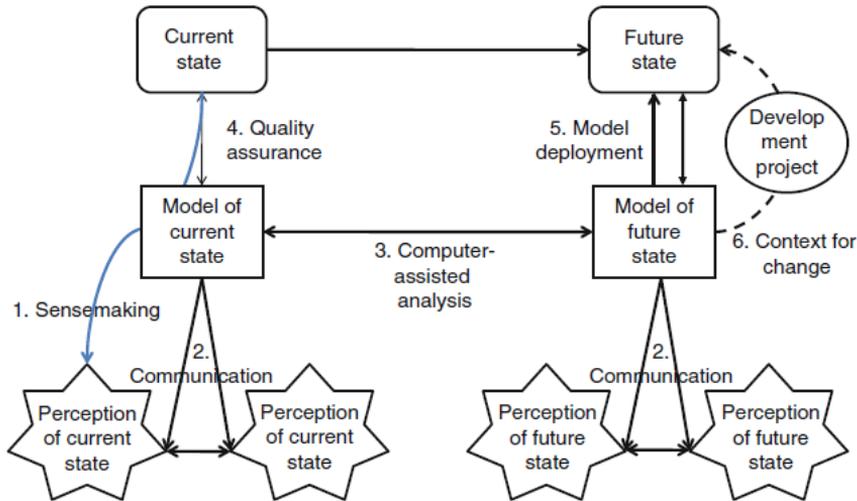


Figure 7.3: Application of conceptual modelling (Fig. 1.3) (69, p. 11)

7.5 Scope for enterprise model and architecture As-Is

This section defines the scope for enterprise model and architecture As-Is supported by TOGAF (45). Input for this section is: Actual NTNU practice is described in chapter 5. Literature and definition of concepts are described in chapter 2. And TIA Case is described in chapter 6.

TIA Case, concepts and Actual NTNU practice are analyzed supported by following TOGAF phases (45):

- Preliminary Phase - Framework and principles
- A - Architecture Vision
- B - Business Architecture
- C - Information Systems Architecture
- D - Technology Architecture

Enterprise model and architecture As-Is is described in Appendix G.

7.6 Scope for enterprise model and architecture To-Be

This section defines the scope for enterprise model and architecture To-Be supported by TOGAF (45). Input for this section is: Best practice principles are described in chapter 4.5. Literature and definition of concepts are described in chapter 2. And TIA Case is described in chapter 6. TIA Case, concepts and Best practice principles are analyzed supported by following TOGAF phases (45):

- Preliminary Phase - Framework and principles
- A - Architecture Vision
- B - Business Architecture
- C - Information Systems Architecture
- D - Technology Architecture
- E - Opportunities Solutions
- F - Migration Planning
- G - Implementation Governance
- H - Architecture Change Management

Enterprise model and architecture To-Be is described in chapter 8.

Enterprise Model and Architecture To-Be

This chapter describes Enterprise Model and Architecture To-Be supported by TOGAF presenting different architectural views. First this chapter is based on best practice for Integration Governance presented in chapter 4.5 and TIA case presented in chapter 6. Second TIA To-Be is based on conversations describing the: Efficient Service Structure Project (66; 68). Third, this chapter based on concepts described in chapter 2: The IT Engagement model and The Four Stages of Architecture Maturity. Finally some models in this chapter have been adjusted or introduced post model evaluation.

The most important vision for TIA To-Be is the TIA architecture displayed in chapter 6, TIA case. Figure 6.1:

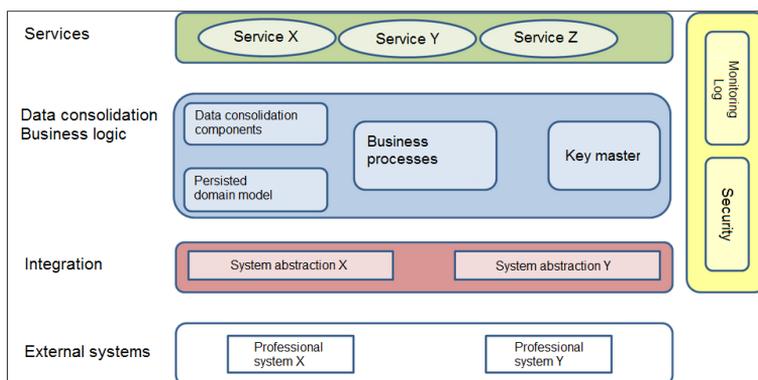


Figure 8.1: TIA system architecture

TIA system architecture represents the template for TIA To-Be. In the figure below the TIA system architecture is realized with data source systems and services supporting business processes.

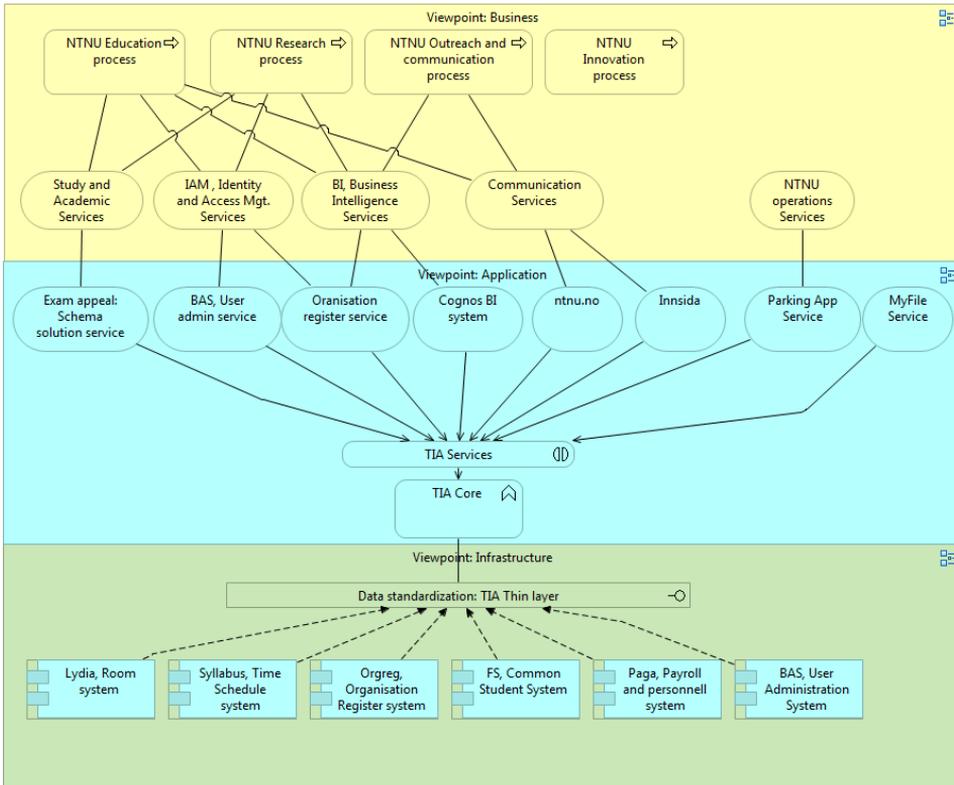


Figure 8.2: TIA To-Be v03

Enterprise model To-Be figure above is mainly based on goals for the vision and targets for the Efficient Service Structure Project. The enterprise model above display:

- B - Business Architecture
- C - Information Systems Architecture
- D - Technology Architecture

8.1 Preliminary Phase - Framework and principles

This phase defines the architecture principles that drive technological architectures and documentation of those (67).

8.1.1 Principles

Principles for EA As-Is where the Difi principles (43) and TIA principles (7). For EA To-Be the principles from Integration Governance Best Practice Analysis Summary (chapter 4.5) are added:

1. *Enhance business process standardization and integration (20) when appropriate*
2. *Strategy and vision for the enterprise and IT anchored*
3. *Implement ITIL framework*
4. *Architecture frameworks as TOGAF are either implemented or TOGAF guidelines are applied: Frameworks should be adapted to the existing organization (32) Architectural guidelines should be described in governance documents.*
5. *The line or business side should own the processes and data (32; 33):*
6. *There should be a forum where data and process owners interact:*
Examples are: The Statkraft priority board, Statoil IT-arena (38, p. 38) and Statoil product owner arena (32). Responsibility and delegated authority (decision model) should be defined in governance documents.
7. *Architectural guidelines should be defined in governance documents:*
A project or team can define detailed architectural principles based on guidelines. Having guidelines described in governance document and detailed integration principles defined at a lower level make it possible to avoid conflicts concerning architecture perceptions (32). A breach of architectural guidelines must be reasoned (27).
8. *Decisions must follow guidelines and defined IT-Governance structure (engagement model):*
Decisions can be made at lowest possible level (32; 34). This unless it interferes with degree of standardization and follows defined IT-Governance structure.
9. *The IT system shall not pass the border for the business process:*
10. *Describe information models and master data models for the most important information objects (32).*

8.1.2 Framework

From Best Practice Analysis Summary: *Architecture frameworks as TOGAF are either implemented or TOGAF guidelines are applied.* Framework applied is the TOGAF ADM method including phases (A-H).

8.1.3 NTNU Information Security Policy and Principles

The documents Policy for Information Security and Principles for Information Security (77) regulates the Information Security at NTNU. The documents are approved by the NTNU Rector. The table below visualize the Information Classification and Security Levels. Se figure below.

Security Level	Type of information / Information system	Area	Securing
Red	Information classified as: <i>Strictly confidential</i> and Confidential Information system classified as: <i>High</i>	Restricted areas where special authorization is required, data/server room/archives with confidential information and similar. Rooms with infrastructure representing high vulnerability/risk for critical or larger parts for NTNU's enterprise	Locked day and night. Access card or key with very limited access.
Yellow	Information classified as: <i>Confidential</i> Information system classified as: <i>Medium</i>	Technical rooms with infrastructure representing high vulnerability/risk for restricted parts of NTNU's enterprise, printer rooms, archive rooms, meeting rooms and office areas that might contain information classified as <i>Confidential</i>	Locked day and night. Access card or key. For printer rooms the room itself placed in blue or yellow zone printing classified information. Secure printing functionality is then required.
Blue	Information classified as: <i>Internal</i> Information system classified as: <i>Medium</i>	Offices, computer workshops, meeting rooms etc. where access control is required day and night. Areas that might contain information classified as <i>Internal</i>	Personal key card, lock, access via reception.
Green	Information classified as: <i>Open</i> Information system classified as: <i>Low</i>	Public available areas: Mingling areas, corridors, canteen etc. By principle everything is defined as open.	Boundary protection for buildings outside opening hours and eventually extra securing measures. E.g. guard at libraries video monitoring etc. The securing measures are based on risk analysis and assets placed in areas.

Figure 8.3: Information Classification and Security Levels

Please note the NTNU Information Security Principles is placed in the To-Be model reasoned by a more holistic view.

8.2 A - Architecture Vision

Define the scope of the architecture project and Define high level business requirements (67).

8.2.1 Scope for the architecture project

- TIA vision: "The goal for TIA is to prepare for service oriented architecture at NTNU. The goal is to model an architecture that arrange open data access at NTNU and in an efficient and agile method can be expanded for new data sources and requirements. Data sources shall be replaceable and the local implementations shall not be restricted by implementation of the source" (7).
- The Efficient Service Structure project has a vision: "Everything in and out via TIA".

Architecture Vision is approved by stakeholders as the project is a part of the official NTNU Basis IT program. This as part of the NTNU-IT project portfolio (51).

8.2.2 Define high level business requirements

Integration Governance Best Practice Analysis Summary Principles (chapter 4.5) is relevant: *Enhance business process standardization and integration (20) when appropriate.*

8.2.3 Architecture development initiative

Architecture development initiative in the EA To-Be is represented by the Efficient Service Structure Project (66).

8.2.4 Identifying stakeholders

Stakeholders for Enterprise Model and Architecture To-Be:

- Communication division
- Student and Academic division
- HR-Division
- Economy Division
- Technical Division (Access Control Unit)
- Students and employees
- Developers and system admins
- Projects, programs and managers

8.2.5 Identifying Ownership

From Integration Governance Best Practice Analysis Summary (chapter 4.5) ownerships should be defined: *The line or business side should own the processes and data (32; 33)*

- NTNU Education process
 - Prorector for Education is process owner and data owner
 - Director Student and Academic division has delegated authority

- NTNU Communication process
 - NTNU Organization Director Education is process owner and data owner
 - Director Student and Academic division has delegated authority

8.3 B - Business Architecture

The objective is to define and describe the product or service strategy, and the organizational, functional, process, information, and geographic aspects of the business environment (67).

8.3.1 Post evaluation: Improved organization map with defined data ownership

The model evaluation conducted in chapter 10 (Model evaluation) revealed that the model for organization (Business View Process and Function Owners v04 in Appendix I) was incomplete. See chapter 10.4.1 Semantic and perceived semantic quality, Completeness: The model and mindset is correct, however the terminology used in the model does not fit for NTNU. One must take a step further which is the organization map for NTNU, add a familiar language/terminology and then match it to the model. (83).

As a consequence of the evaluation of completeness the organization model was improved to be more complete. See figure 8.4 below. (Please note that the figure below has different color codes representing a model created after evaluation.)

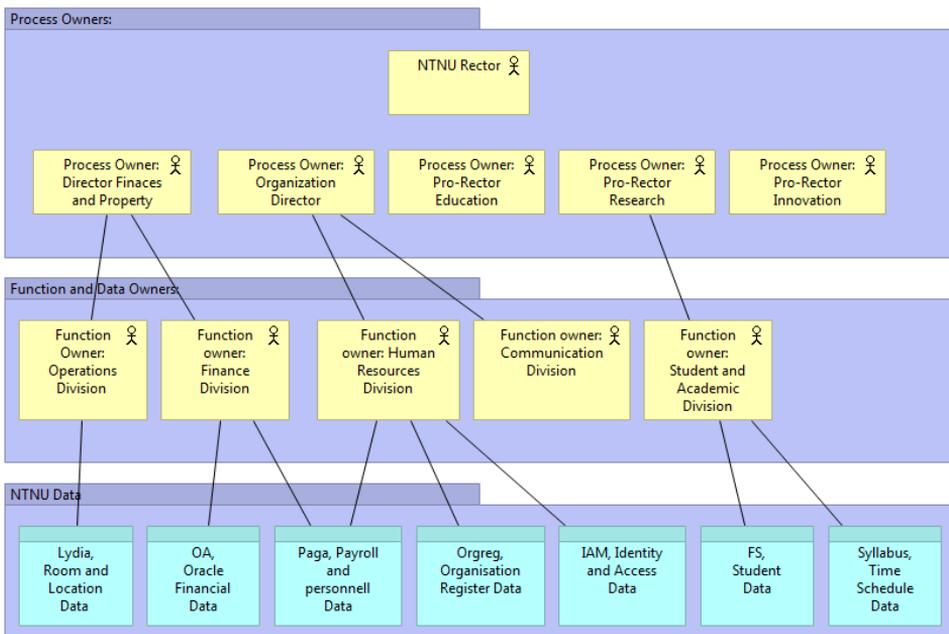


Figure 8.4: Improved Business View Process and Function Owners

8.4 C - Information Systems Architecture

The objective is to define the major types and source of data necessary to support the business. It is NOT about database design. The goal is to define the data entities relevant to the enterprise (67).

8.4.1 Application Architecture

Application Architecture To-Be:

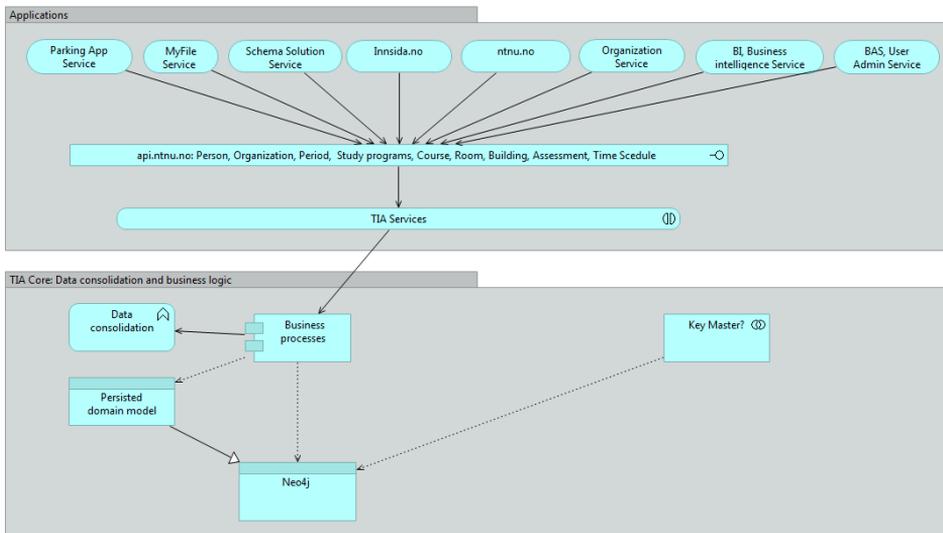


Figure 8.5: TIA application View To-Be

8.4.2 Information Architecture

From Best Practice Principles point 9: *Describe information models and master data models for the most important information objects* (32). This subsection aim to describe the most information objects in FS. Refer to problem description (1) point 2: "Study TIA Case. Focus on FS, Common Student System." FS general information model: In the figure above the most important information objects in FS and their relations are presented. The FS database is a large database containing about 800 database tables. The five information objects above: Role, Organization unit, Person, Study Program and Course are the main information objects in FS. Most tables and function in FS are mainly support functions for the main information objects above (72).

8.4.3 Information Model

An information model of the most important information objects (Ref: Best practice summary point 9) The information model is defined by Examination Regulations at the

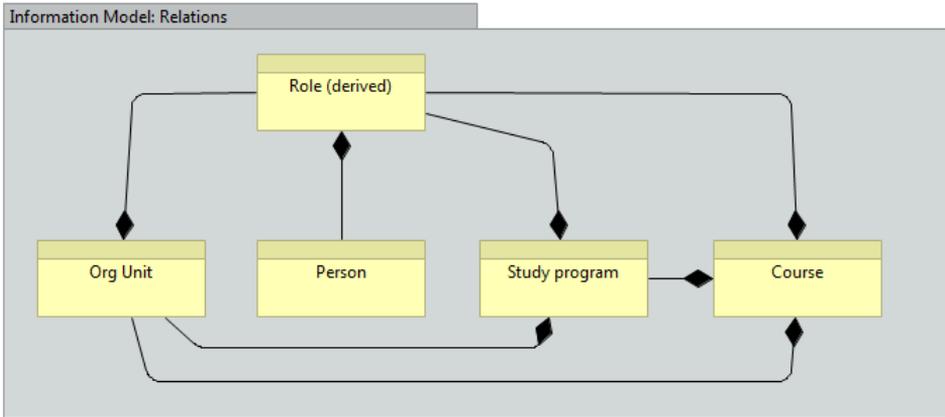


Figure 8.6: TIA-FS General Information Model v02

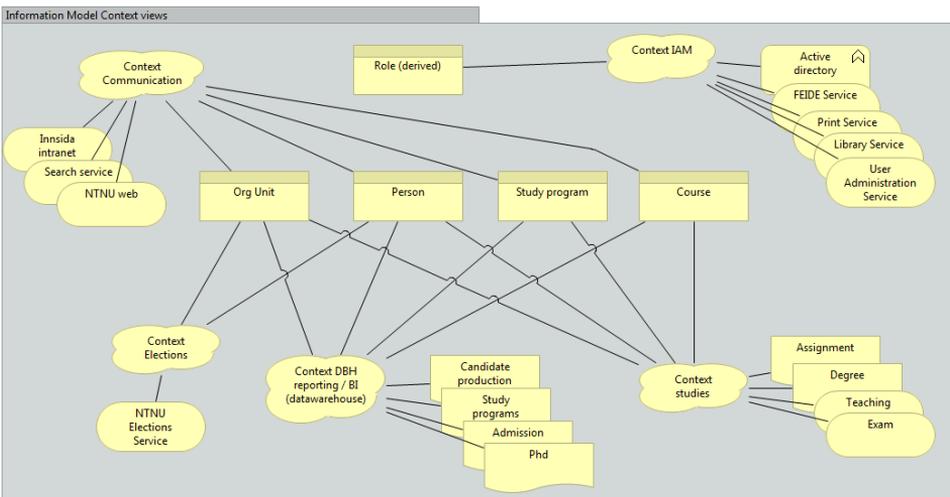


Figure 8.7: TIA-FS Information Model v02

Norwegian University of Science and Technology (NTNU) (70)

- **Course** - The smallest unit in which the student can receive an assessment and course grade. The extent of the course is measured in credits. The course involves activities that form the basis for assessment. The activities may be compulsory.
- **Subject** - A collection of courses in one group in a programme plan.
- **Programme of study** - A group of courses that forms one academic entity that students can apply for admission to, receive the right to study, and leads to a degree.
- **Assessment** - The evaluations a student receives on the basis of his/her performance in a course, or a group of courses and that lead to a grade.
- **Final examination** - A type of assessment that normally follows at the end of the semester under conditions that can be controlled. The final examination generally is the concluding assessment of the student in a course or a group of courses.

These regulations refer to the Act relating to Universities and University Colleges of 1 April 2005, no. 15 (71).

8.4.4 Data ownership and service complexity

The data ownership and service complexity view aim to provide a map over the data sources and ownership applied in the application service composition (api.ntnu.no). It also aim to proved a map for tracking and decision support for data and process owners. Se figure below. E.g. By tracking meaning a map to see the consequences of change in source systems affecting the application services. Each source system have one distinct color. And the source system colors are applied to visualize how the application services are composed. See figure below. It is basically figure 9.2 composed with different color codes.

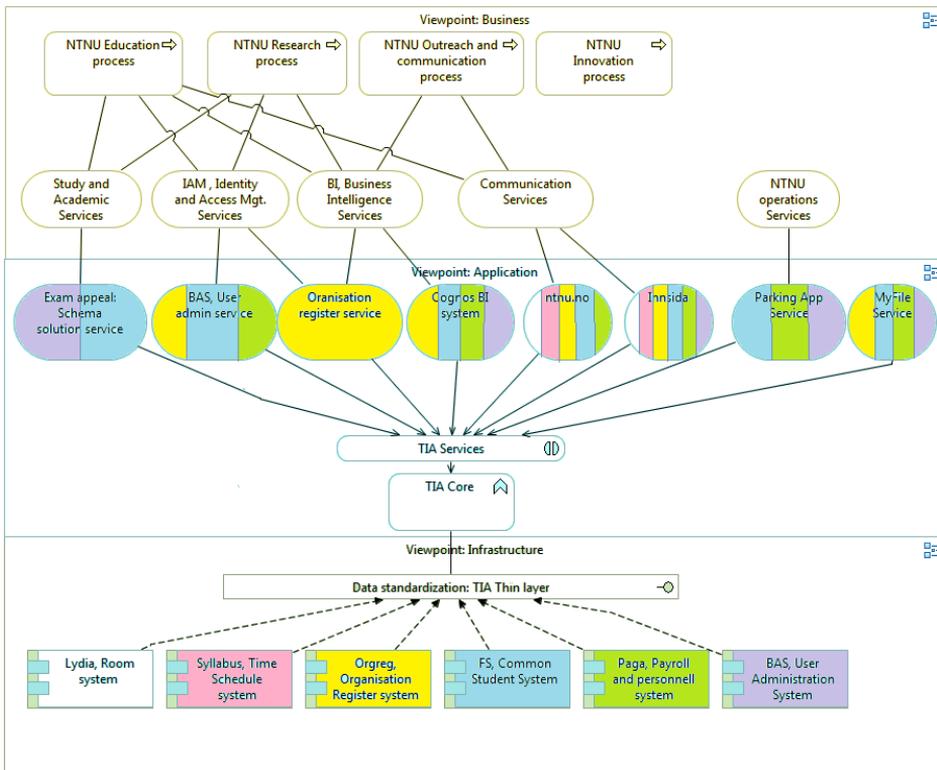


Figure 8.8: Data ownership and service complexity

8.4.5 Information Security

Information security at NTNU are regulated by Policy for Information Security and Principles for Information Security (77). Figure 8.3 describes Information Classification and Security Levels.

8.4.6 Post evaluation: Improved model for security and classification of information

The model evaluation conducted in chapter 10 (Model evaluation) revealed that the model for security and classification of information was to weak. In the table 10.1: Score Model Evaluation (chapter 10) the score for Security and categorization of information (Q5) did get a low score (2.6).

As a consequence of the evaluation an improved model for security and classification of information was created. The improved security and classification model introduce business functions, business roles and business actors (Archi notation) related to security and classification of information. See figure 8.9 below. The model is based on model Evaluation interviews with Developer (89) and Security Manager at NTNU (86).

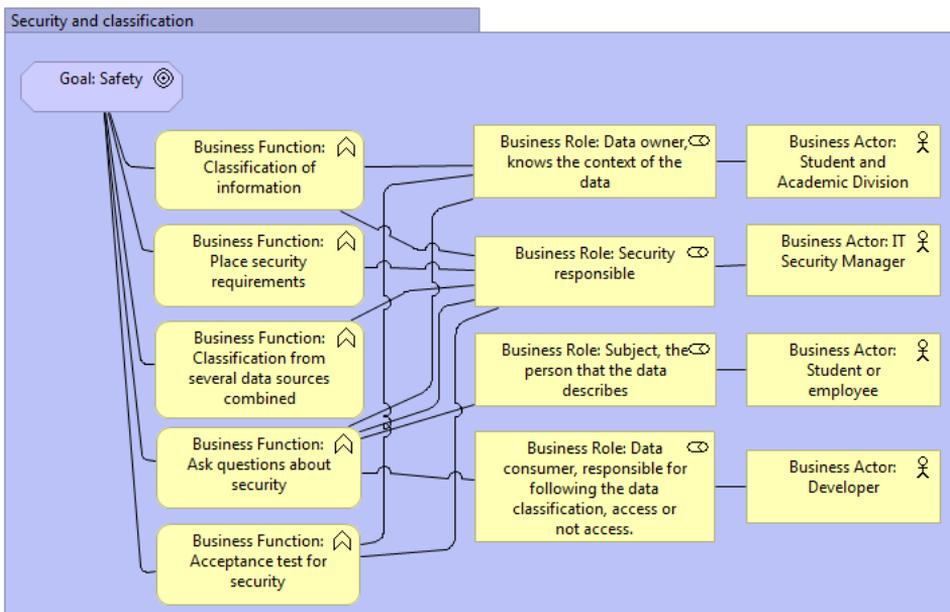


Figure 8.9: Improved model for security and classification of information

(Please note that the figure above has different color codes representing a model created after evaluation.)

8.5 D - Technology Architecture

The objective is to define the technology and technical services that will form the basis of the following implementation work (67).

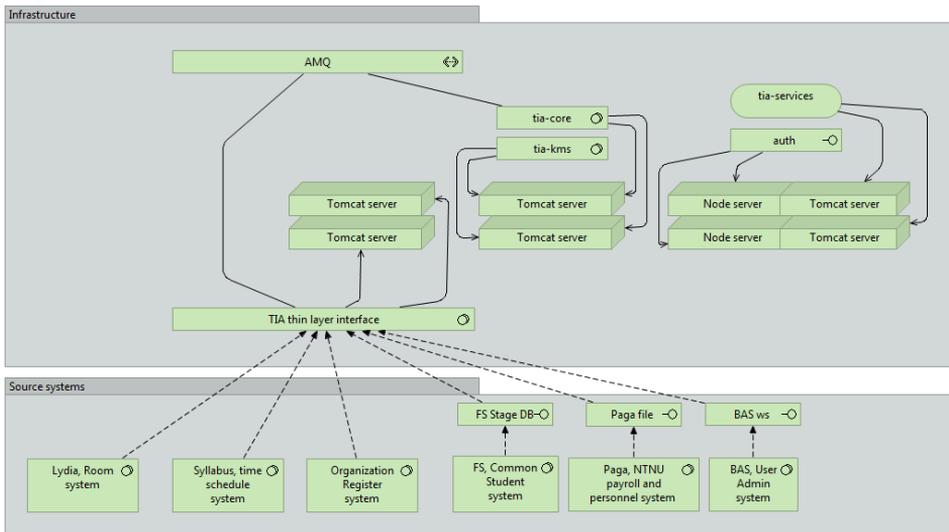


Figure 8.10: TIA Technology To-Be v01

The Changes in the TIA technology infrastructure To-Be (figure above) is mainly removal from the Service Layer as modeled in TIA technology infrastructure As-Is (Appendix G).

8.6 E - Opportunities Solutions

The first phase directly concerned with implementation. How to close the gaps? Identify implementation projects (67).

8.6.1 Closing the gaps

The project Efficient Service Structure has following target: Utilize TIA for improved IT-Operations and improved services for the customer. The vision for the project is: "Everything in and out via TIA" (66).

The Efficient Service Structure project aim to close the gap regarding standardization of information services using TIA as a platform. The Efficient Service Structure Project has following priority list has following priority list closing the gaps (66):

1. Syllabus data (NTNU Time Schedule system). Remove from Service-Layer.
2. Entrance card control system project.

3. Replace Service Layer. Effect: Release developer resources and improved cooperation against the NTNU Communication Division.
4. Christin (Research reporting system). TIA is delivering authorization data.
5. BAS (User Administration System). Requires more data.

8.6.2 Opportunities

Opportunities for TIA and future NTNU services and projects is in this thesis is found through conversations with NTNU project and program managers.

Opportunities related to services (75):

- Couple data across the NTNU organization: Room, studies and student mass roles. E.g. a student purchasing relevant literature at the Academica book store. Because you are a student the required reading list can be automatically generated.
- E.g. Calendar service and Mazemap. A simple tool for indoor navigation: Mazemap.com
- For the consumer active use of TIA will give the same data result each time.
- Time to market. To take in new data sources has shorter implementation time.

Opportunities related to TIA and the NTNU program: "IT in Education" (75):

- Now: With TIA the data elements exist only one place.
- A new LMS (Learning Management System) do not need to transfer and store data.
- Easier to remove LMS when purchasing a new LMS. Modularization.

Technical service opportunities (75):

- This will influence future services and projects
- The update frequency of information is not dependent on nightly batch job.
- Stability: Upgrading nodes can be done without downtime.
- Reduced dependency on suppliers.
- Easier to avoid vendor locking.
- Avoiding double storage of data.
- Removal of complexity.
- In principle there is only one data element. Then the data ownership is clearer.

8.7 F - Migration Planning

Prioritize between implementation projects (67):

- I.e. project portfolio management
- Cost and benefit analysis
- Risk assessment

8.7.1 Project portfolio

Referring to TIA relevant project portfolio described in chapter 6.5 TIA roadmap.

8.7.2 Prioritize

Referring to priority list for the Efficient Service Structure Project: Chapter 8.6 E - Opportunities Solutions.

8.7.3 Cost and benefit analysis

- Cost Benefit analysis has not been done so far in TIA context (75).
- Cost benefit analysis should be done as a part of governance (75).
- "Have not found any cost benefit analysis of a SOA implementation. Only one project could say it had a cost benefit. It is difficult to visualize the effects of a SOA implementation on the bottom line. The effects are more soft values as security, stability and time to market. The effects on a SOA implementation is not measured as profit and loss. It takes many years before you get return on investment (ROI)" (75).

8.7.4 Risk assessment

Following risk are for the TIA project are identified (75):

1. Authorization is the largest risk. Is is a potential show stopper for making TIA efficient. Have been waiting for the IAM project.
 - Now authorization rules are being hard coded. This is very ugly.
2. What are authoritative sources for what? Several authoritative data sources for the same data is complicating write-back. Ideally one data element should have one source only.
3. Not implementing a center of excellence is a huge risk:
 - No governance function
 - No life cycle management

- A possible improvement loop is disappearing. Why where things made as they are?
 - The choices made must be reasoned and based on a strategy!
4. Ignoring design the principle low coupling and high cohesion is risky in TIA context.
- Following risk are for the Efficient Service Structure Project are identified (66):
1. Changing integration for the Cristin system have a large risk. This because of many stakeholders.
 2. The FS integration in connection with outsourcing is a large risk. There are several interfaces in current integration solution. It is unclear how these interfaces will be implemented when outsourced.
 3. Least risk is integration between TIA and BAS.

8.8 G - Implementation Governance

Architectural contract. Ensure compliance with the defined architecture. Implementation specifications acceptance criteria (67). The objectives of Phase G are to (45):

- Ensure conformance with the Target Architecture by implementation projects
- Perform appropriate Architecture Governance functions for the solution and any implementation-driven architecture Change Requests

8.8.1 IT-Governance engagement model

To perform appropriate Architecture Governance functions with the defined architecture a IT-Governance engagement model (23) is proposed defining who is taking which decisions in this thesis. The IT-Governance engagement model does concern governance related to TIA as Information System Integration (12) regards all levels: Business Architecture, Application Architecture and Technology Architecture (figure 2.1).

	IT Principles		IT Infrastructure		IT Architecture		Business Applications*		IT prioritization and Investment	
	Input	Decision	Input	Decision	Input	Decision	Input	Decision	Input	Decision
Business Monarchy										
IT Monarchy										
Feudal										
Federal										
Duopoly										
Anarchy										

Figure 8.11: Template: Governance Arrangement Matrix

What decisions must be made and who should make them? Below are five key decisions illustrating Decision Domains (23):

- IT principles: Clarifying the business role of IT.
- IT architecture: Defining integration and standardization requirements.
- IT infrastructure: Determining shared enabling services.
- Business application needs: Specifying the business need for purchased or internally developed IT applications.
- IT investment and prioritization: Choosing which initiatives to fund and how much to spend.

One or more people are responsible for making each of these decisions. Typically, many more people provide input to these decisions. It Governance involves defining who will be responsible for both input and decision making for each decision. The row heading in figure above set a list of archetypes for specifying decision rights illustrating Governance Archetypes (23):

8.8.2 Best practice and Statoil

Integration Governance Best Practice Summary point 6 (Chapter 4.5) is a guideline: *There should be a forum where data and process owners interact.* Examples are: The Statkraft priority board, Statoil IT-arena (38, p. 38) and Statoil product owner arena (32). Responsibility and delegated authority (decision model) should be defined in governance documents. This may be handled in a Center of Excellence as implemented at Sykehuspartner (33).

The Statoil Arenas (38, p. 38): The purpose of the arenas is to provide quality and consistency across the organization before important decisions are made. Three arenas support quality in decision-making within their particular specialist skills:

- Information technology arena
- Technology arena
- Investment arena

The arenas ensure that decision-makers understand expectations. For the end result, that risk exposure is realistic and that decision-making meets our requirements.

The information technology arena The information technology arena ensures that the portfolio of major IT initiatives support the company's strategy and creates ownership across the group. The arena must consider the consequences and risks of the company by providing their comments to the IT portfolio and the financial targets set.

In Statoil important roles are: Process owners and Function owners.

Process owners (38, p. 40): Process owners have been appointed for the process areas with a global reach affecting large numbers of people across the organization, to support

business needs and standardization based on best practice.

Function owners (38, p. 42): Corporate functions have the responsibility for staff and support function areas. Head of corporate functions, or an appointed function owner within the corporate function, are responsible for defining corporate policies and requirements, and for driving improvement across the company.

8.8.3 An NTNU IT-Governance engagement model?

By combining the IT-Governance engagement model and best practice represented by Statoil in a NTNU context and NTNU organization (40), a NTNU IT-Governance engagement model can be proposed. The point is visualize how an engagement for NTNU could be:

Business monarchy

Top managers:

- Process owner: Organization Director
- Process owner: Director of Finance and Estate
- Process owner: Pro-Rector Education
- Process owner: Pro-Rector Research
- Process owner: Pro-Rector Innovation

Federal

Combination of the corporate center and the business units with or without IT people involved:

- Function owner: Operations Division
- Function owner: Finance Division
- Function owner: NTNU University Library
- Function owner: Student and Academic Division
- Function owner: Communication Division
- Function owner: Human Resources Division
- Function owner: IT Division
- Function owner: HSE Division
- Function owner: Administrative Services

IT monarchy

IT specialists e.g. the IT-Operations Board and IT Architects:

- IT Division Manager (CIO)
- IT Managers Faculties (E.g. IVT, IME, DMF, HF, IME..)
- IT Architects

Feudal

Each business unit making independent decisions e.g.:

- Faculty of Engineering Science and Technology (IVT)
- IT Manager IVT
- Department of Production and Quality Engineering (IVT)
- Department of Marine Technology (IVT)

IT duopoly

IT group and one other group (for example, top management or business unit leaders) E.g:

- Director of Finance and Estate
- IT Division Manager (CIO)
- Dean Faculty of Engineering Science and Technology (IVT)
- IT Manager IVT
- Student and Academic Division Manager

Anarchy

Isolated or individual or small group decision making e.g:

- Local IT unit for a Faculty or Department
- System Developer
- System Administrator

Comment: When studying the NTNU Organization (Figure 5.1) and the Governance Archetypes for NTNU suggested above a discussion is where to place faculties, departments and users as students and employees.

	IT Principles		IT Infrastructure		IT Architecture		Business Applications*		IT prioritization and Investment	
	Input	Decision	Input	Decision	Input	Decision	Input	Decision	Input	Decision
Business Monarchy		V								V
IT Monarchy			V		V					
Feudal							V			
Federal	V			V		V	V	V	V	
Duopoly			V				V			
Anarchy			V							

Figure 8.12: Proposed NTNU IT-Governance engagement model

Proposed NTNU IT-Governance engagement model

Applying the Governance Archetypes for NTNU suggested above and Decision Domains (23): we get following proposed NTNU IT-Governance engagement model:

One or more people are responsible for making each of these decisions. Typically, many more people provide input to these decisions. It Governance involves defining who will be responsible for both input and and decision making for each decision. The row heading in figure above set a list of archetypes for specifying decision rights illustrating Governance Archetypes (23):

8.8.4 Architectural contract

The architectural contract for TIA is given by the TIA Architecture defined (7). For IT governance principles proposed in this thesis the architectural contract are not decided by NTNU management.

8.8.5 Compliance with the defined architecture

NA: NTNU management first must decide if to apply suggested architecture and IT governance principles.

8.8.6 Implementation specifications - Acceptance criteria

NA: NTNU management first must decide if to apply suggested architecture and IT governance principles.

8.9 H - Architecture Change Management

Handle architecture change requests and Suggest new architecture projects (67). This section introduce four stages of architecture maturity. Each stage represents architecture change requests and suggest new architecture projects to reach a best practice.

8.9.1 The Four Stages of Architecture Maturity

Best practice is this thesis is based on the assumption on high degree of business process standardization and high degree of business process integration (the Unification operation model, figure 2.11). To reach the Unification level Enterprise Architecture as Strategy introduce four stages for architecture maturity (20, p. 71):

1. *Business Silos architecture*: where companies look to maximize individual business unit needs or functional needs.
2. *Standardized Technology architecture*: providing IT efficiencies through technology standardization and, in most cases, increased centralization of technology management
3. *Optimized Core architecture*: which provides companywide data and process standardization as appropriate for the operating model
4. *Business Modularity architecture*: where companies manage and reuse loosely coupled IT-enabled business process components to preserve global standards while enabling local differences.

Each stage involves organizational learning about how to apply IT and business process discipline as strategic capabilities. Advancing through the stages requires lots of persistence, but as companies advance from the first stage to later stages, they realize benefits ranging from reduced IT operating costs to greater strategic agility (20, p. 71).

8.9.2 Steps of Management Practices

This subsection presents steps of management practices to conduct at each architecture maturity stages (20, p. 104).

Stage 1: Business Silos

Only two practices proved critical for supporting companies efforts to generate value from the Business Silos stage (20, p. 104):

1. *Business cases*: accurate and compelling analysis of the expected costs and benefits of a proposed change to a business process or technology.
2. *Standardized project methodology*: a disciplined, consistent approach to converting an approved project concept into an improved business process.

Stage 2: Standardized Technology

Three critical management practices in stage 2 address issues related to more centralized IT funding (20, p. 105):

1. *An IT steering committee*: a small group of executives held accountable for determining IT priorities.
2. *Centralized funding of enterprise applications*: capital budget allocations supporting implementation of enterprisewide standards.
3. *An infrastructure renewal process*: a funding mechanism for projects intended primarily to retire aging technologies and upgrade the technology base.

Four other practices relate to managing a standardized technology environment:

1. *A formal architecture compliance process*: a process for ensuring new projects are adopting standard technologies.
2. *Architects on project teams*: individuals responsible for ensuring that technical standards are observed or that necessary exceptions are adopted.
3. *An architecture exception process*: a formal process for identifying when exceptions to standards add value.
4. *A centralized standards team*: technical experts who identify appropriate standards and recognize when to retire or update those standards.

Stage 3: Optimized Core

Stage 3 management practices help companies to understand the need for process integration and standardization and to adjust to the resulting organizational changes. Process standardization depends on senior management leadership (20, p. 107):

1. *Enterprisewide process owners*: individuals who own, design, and implement one or more enterprisewide processes.
2. *A statement of enterprise architecture guiding principles*: tough choices specifying how IT will be applied in the company (e.g., to serve customer interests versus to cut business process costs)
3. *Business leadership of project teams*: high-level managers accountable for generating expected benefits and actively involved in project management.
4. *Senior executive oversight of enterprise architecture*: high-level reviews of enterprise architecture initiatives and design of incentives to encourage adoption.
5. *IT program managers*: individuals who coordinate systems and projects to map integration and minimize redundancy.

Stage 4: Business Modularity

Companies in the fourth stage are sophisticated users of IT. They have developed disciplined business processes and are learning how to define standard process components, enabling greater agility in response to different business opportunities and customer needs. The critical management practices in this stage focus on how companies communicate architecture goals and assess their IT-enabled business change initiatives. Four practices are key to stage 4 (20, p. 108):

1. *A one-page core diagram*: a tool that communicates a high level picture of integration and standardization requirements.
2. *Post implementation assessment*: a formal process for securing and communicating lessons learned from each project.
3. *A formal research and adoption process*: a process for identifying the new technologies that could have a significant impact on the company.
4. *A full-time enterprise architecture team*: IT staff who help fit immediate business needs into the company's longer-term vision.

8.10 Requirements Management

Handling new and changing requirements from architecture projects, IT projects, change projects, operations, etc. (67).

Not defined in scope: Chapter 7.6 Scope for enterprise model and architecture To-Be. Requirements Management is partly to be handled by figure 8.15: Proposed NTNU IT-Governance engagement model described in chapter 8.8 phase G - Implementation Governance. The Requirements Management process is not described.

8.11 Development and test of Enterprise model To-Be

Documentation of model development and test process is described in Appendix I.

Best practice Integration Governance model and gap analysis

This chapter aim to align the Enterprise Model and Architecture To-Be (chapter 8) with Foundation of Execution (20). And it aim to present a gap analysis identifying gaps between actual practice and best practice.

In chapter 2.6 the concept Foundation of Execution was introduced. To Build a Foundation of Execution companies must master three key disciplines (20):

1. Operation Model
2. Enterprise Architecture (EA)
3. IT engagement model

In the previous chapter an EA To-Be is derived by applying TOGAF ADM analysis method. And the EA To-Be is based on based on Best Practice analysis (chapter 4). The EA To-Be proposes an IT Engagement model: Figure 8.12 based on best practice. A best practice operation model "Unification" is defined in chapter 4.2. By applying Enterprise Architecture (EA), IT Engagement model, best practice operation model "Unification" from Foundation of Execution (20) representing best practice from literature, a Best practice Integration Governance model can be presented.

9.1 NTNU Foundation of Execution based on best practice

The Enterprise architecture To-Be represents a best practice with following Foundation of Execution elements:

1. Operation model: "Unification" (figure 2.11) representing high degree of business process standardization and high degree of business process integration (20):

- Enterprise architecture (EA): Figure 8.2: TIA To-Be represents Enterprise Model and Architecture To-Be
- IT engagement model. Figure 8.12: Proposed NTNU IT-Governance engagement model

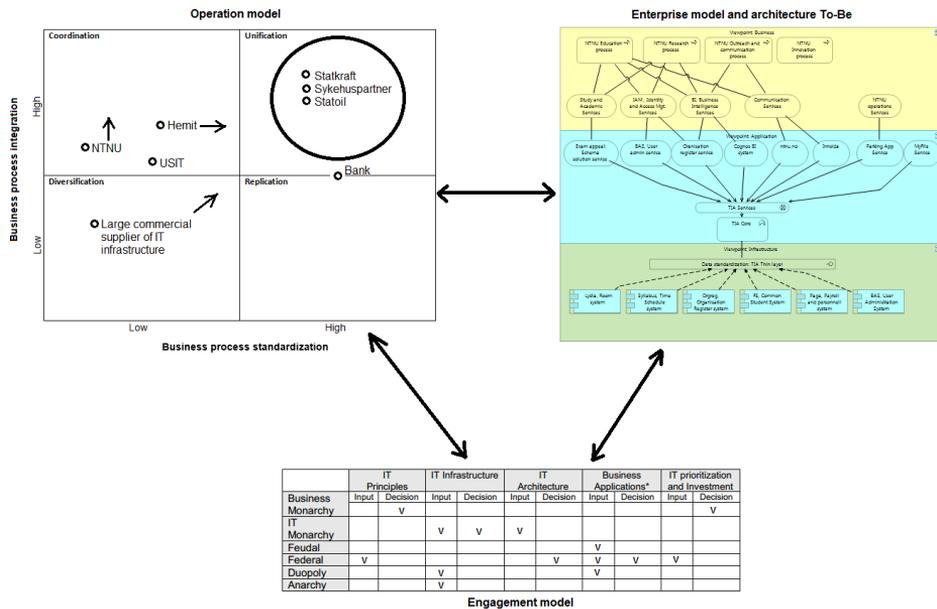


Figure 9.1: Best practice Integration Governance model

The best practice Integration Governance model cover different architectural views representing similar and overlapping architectural structures compared to TOGAF views presented in chapter 8.

9.1.1 How will EA, Engagement model and Operation Model affect each other?

How will EA, Engagement model and Operation Model affect each other. What are the consequences? In my opinion the NTNU Schema Service Project (73) described in Appendix H represents very good example on the consequences of a lacking operation model (standardization and integration), IT Governance and Enterprise Architecture (EA).

9.1.2 Example chosen: NTNU Schema solution

If applying the Foundation of execution as described above using the NTNU Schema Service Project (73) described in Appendix H. How would the Enterprise Architecture

To-Be and Foundation of execution affect architectural processes and a future solution for Schema Service Project?

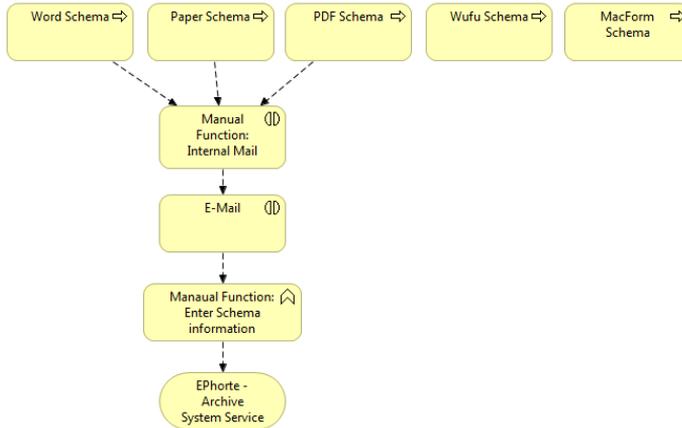


Figure 9.2: Schema solution As-Is

The figure above (Schema solution As-Is) illustrate an opposite situation with low degree of business process standardization and low degree of business process integration.

9.1.3 How does the Operation model and EA To-Be affect each other?

High Degree of standardization and integration of business processes (Unification) requires an EA supporting high degree of integration. And TIA supports the integration business processes axis. On the other hand an EA supporting high degree of integration of business processes requires a strategy supporting that implemented by the operation model.

In this NTNU Schema solution example TIA supported by TOGAF offers an EA with a standardized and integrated data set, API (api.ntnu.no, figure 8.5) and which application services supporting which business services supporting enterprise processes. This represented by business view and application systems view and Technology view (figure 8.2)

EA provides a map of which application services supporting which process. Not all processes fit for standardization and integration (cite). The EA makes it easier to determine which process that fit. For the NTNU Schema solution example supports the Operation model by offering standardized and integrated data set, API (api.ntnu.no, figure 8.5) The consequence for the NTNU Schema solution example would be one single standardized Schema solution for NTNU with pre-filled data from one single data interface (api.ntnu.no).

9.1.4 How does the Operation model and the Engagement Model affect each other?

High Degree of standardization and integration of business processes (Unification) figure 2.11 requires that IT decisions are made centrally.

For the NTNU Schema solution example with the proposed NNTU IT engagement model figure 8.12 with Federal Governance archetype (chapter 2.4.2) implemented decisions would be made centrally. The consequence would be the ability take central decisions implementing a standard Schema Solution for NTNU with centralized funding of enterprise applications (Chapter 8.9.2 Steps of Management Practices: Stage 2 Centralized Technology).

9.1.5 How does the EA To-Be and the Engagement Model affect each other?

A definition of EA is: "A formal description of an enterprise, a detailed map of the enterprise at component level to guide its changes" (chapter 2.3.2). The IT engagement model describes who is giving input to and taking which decisions. To be able to perform the right decisions EA To-Be represents the detailed map of the enterprise at component level to guide its changes.

For the NTNU Schema Solution project an implemented EA To-Be and and implemented Engagement model the consequence would be: Decision makers will have an ability to see the requirements for a Schema Solution from an Enterprise perspective. Also the consequence would be the ability provide an understanding and perception of complexity components are related (EA To-Be) and why an engagement model is required. This displaying the complexity regarding data ownership, process ownership, how services supports the processes and the impact of changes.

9.1.6 Does the model fit to NTNU?

This section raise the question weather the model described is figure 9.1 fit to NTNU. In the survey reported in chapter 4 both universities UIO and NTNU ended with the least score. See table 4.1: Survey score. What might be the reason for this situation? From my point of view this might be caused by high degree of organizational autonomy and culture of academic freedom. From this perspective it is relevant to ask: Does the model (figure 9.1) fit to NTNU and a university?

9.2 Gap analysis

A transition from an As-Is situation to a To-Be situation. What measures must be taken? This section describes the gap analysis getting from an EA As-Is to an EA To-Be. The EA To-Be is also visualized as the foundation of execution figure 9.1. The gap analysis will be performed applying The Four Stages of Architecture Maturity described in chapter 8.9.1 and the principles for Integration Governance best practice described in chapter 4.5. and

compare it to actual NTNU practice described in chapter 5. Gap analysis will probably be colored by my personal view. This based on nearly 10 years of work experience at the NTNU IT Division. In the analysis below the practices and principles representing a gap will be marked: Not in place, not reported or similar.

9.2.1 Integration Governance best practice principles

Integration Governance best practice can be summarized to following rules and principles for an enterprise:

1. *Enhance business process standardization and integration (20) when appropriate:* Partly in place. Currently implemented by programs as reported in chapter 5.4.1. However is not a defined strategy and is it not defined as a policy.
2. *Strategy and vision for the enterprise and IT anchored:* Partly in place: Strategy for the enterprise is defined and IT strategy for the IT Division is defined reported in chapter 5.3. and 5.1.1. However, there is not an defined IT strategy or IT policy for NTNU. However, the IT strategy does not describe degree of standardization and integration of business process.
3. *Implement ITIL framework:* In place. ITIL is implemented to a large degree as reported in chapter 5.5.
4. *Architecture frameworks as TOGAF are ether implemented or TOGAF guidelines are applied:* Partly in place: The TOGAF implementation is started, however it is far from complete as reported in chapter 5.2.
5. *The line or business side should own the processes and data (32; 33):* Partly in place: Process owners are defined. "The Norwegian State and NTNU as organization" own the data. However the data ownership is not defined (49).
6. *There should be a forum where data and process owners interact:* Not in place
7. *Architectural guidelines should be defined in governance documents:* In place. Referring to ICT target picture document (42).
8. *Decisions must follow guidelines and defined IT-Governance structure (engagement model):* Not in place.
9. *The IT system shall not pass the border for the business process:* Not in place.
10. *Describe information models and master data models for the most important information objects (32):* Not in place.

9.2.2 Four Stages of Architecture Maturity

To reach the Unification level (best practice) the Enterprise Architecture as Strategy introduce four stages for architecture maturity (20, p. 71): Walking through the four stages of maturity comparing with it with the actual practice reported in chapter 5 and EA As-Is in Appendix G will visualize a gap.

Business Silos architecture

1. *Business cases*: Partly in place. Covered by PAM project method and pre project phase reported chapter 5.2. However, the model evaluation interviews revealed a lack in analyzing business cases: "In general, at NTNU, there is not a concept for evaluating business cases" (86) and "NTNU are not good at business cases" (81).
2. *Standardized project methodology*: In place. The PAM project method reported in chapter 5.2.

Standardized Technology architecture

1. *An IT steering committee*: In place: The IT-board reported in chapter 5.4.
2. *Centralized funding of enterprise applications*: Not in place, not reported
3. *An infrastructure renewal process*: In place: Implemented by the Basis IT II program as reported in chapter 5. However it is not a continuous process.

Four other practices relate to managing a standardized technology environment:

1. *A formal architecture compliance process*: Not in place, not reported
2. *Architects on project teams*: Not in place, not reported
3. *An architecture exception process*: Not in place, not reported
4. *A centralized standards team*: Not in place, not reported

Optimized Core architecture

1. *Enterprise wide process owners*: Partly in place: Process ownership is defined (49).
2. *A statement of enterprise architecture guiding principles*: Not in place, not reported
3. *Business leadership of project teams*: Partly in place: Business leaders are program owners. Reported in chapter 5.4.1
4. *Senior executive oversight of enterprise architecture*: Not in place, not reported
5. *IT program managers*: In place: Reported in chapter 5.4.1

Business Modularity architecture

1. *A one-page core diagram*: In place, reported in chapter 5.2 see figure 5.2.
2. *Post implementation assessment*: Partly in place, reported in chapter 5.2. However, There is no RIO analysis of programs. (81)
3. *A formal research and adoption process*: Not in place, not reported
4. *A full-time enterprise architecture team*: In place to some degree, reported in chapter 5.2.

9.2.3 Analysis

Walking through the four stages of enterprise maturity and comparing it to NTNU practice found that some practices are in place and some practices are not in place at all maturity levels. In general, from my point of view, NTNU is on maturity level 2: Standardized Technology architecture. This reasoned by the programs as Basis IT II program and the IT in the enterprise program were the main goal is to standardize the IT infrastructure at NTNU and supporting the most applied processes in the enterprise area in a uniform manner as reported in chapter 5.4.1.

Chapter 10

Model evaluation

In this chapter the best practice Integration Governance model (figure 9.1) is evaluated. Does the model meet its purpose? And does the model fit to NTNU? This chapter presents: Purpose of the model, quantitative evaluation, evaluation based on competency questions (QC), qualitative evaluation and evaluation by SEQUAL.

10.1 Purpose of the model

Purpose of the model is to support the assignment and problem definition described in chapter 1.1 and chapter 1.3. "The main purpose of the Integration Governance model is to govern how decisions are made among stakeholders concerning integration at NTNU". In addition the purpose of the best practice model (figure 9.1) is to derive a functioning Integration Governance model for NTNU.

10.1.1 Model Stakeholders

The model has several stakeholders each with different perspectives. What these stakeholders have in common is a stake in TIA and the best practice Integration Governance model (figure 9.1):

1. Main stakeholder and principal: Section Manager, NTNU
2. Project manager 1, NTNU
3. Adviser and senior adviser, NTNU
4. Project manager 3 and Senior engineer, NTNU
5. Project manager 2, NTNU
6. Security manager, NTNU
7. Developer, NTNU

8. System administrator, NTNU
9. IT Director, NTNU
10. Director of Organization, NTNU

TIA and model stakeholders are interview regarding model evaluation. See Appendix J.

10.1.2 Quantitative evaluation

Quantitative model evaluation is conducted by interviews (Appendix J). The questions below are based on the purpose of the model (chapter 1.3). The main purpose of the Integration Governance model is to govern how decisions are made among stakeholders concerning integration at NTNU. The best practice Integration Governance Model (figure 9.1) is referred to as the model. Does the model govern how decisions are done regarding:

- Q1: IT-operations?
To what degree? (1 - 5)
- Q2: Orders (Delivery of integrations to new projects or systems)?
To what degree? (1 - 5)
- Q3: Change in source system, interfaces or target system
(Change in applications)?
To what degree? (1 - 5)
- Q4: Change of requirements by system owner or end user
(Meaning change in work processes)?
To what degree? (1 - 5)
- Q5: Security and categorization of information?
To what degree? (1 - 5)
- Q6: Information and context
(Data and information and have different meaning depending on context)?
To what degree? (1 - 5)

Control questions:

- Q7: Does the model provide a target picture for governance of integrations processes (model).
To what degree? (1 - 5)
- Q8: Does the model fit to NTNU?
To what degree? (1 - 5)

Evaluation score is displayed in the table 10.1 Score model evaluation below. The table contains score from evaluation interviews (Enr) and questions based on purpose of the model (Q1-Q8). In addition table 10.1 display score for model evaluation based on competency questions (QC).

Enr	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
1	5	4	4	4	2	4	4	4
2	4	3	4	3	3	3	3	2
3	na	na	na	na	na	na	-	-
4	3	4	3	4	1	4	3	4
5	5	3.5	3.5	3.5	4	5	3	4
6	4	4	5	4	3	5	5	4
7	na	na	na	na	na	na	3	3
8	2.5	2.5	3.5	2	3	3	2	3
9	3	1	3	2.5	4	4	3.5	2
10	4	5	2	1	1	1	4	4
Avg. score	3.8	3.4	3.5	3	2.6	3.6	3.4	3.3
QC	4	3	5	3	3	4	4	4

Table 10.1: Score model evaluation

The highest average score (3.8) is related to Q1 (Does the model Govern how decisions are done regarding IT-operations?). The lowest lowest average score (2.7) is related to Q5 (Does the model Govern how decisions are done regarding security and categorization of information?). The score related to Q8 (Does the model fit to NTNU?) is 3.4. The score indicated that the model fit to NTNU slightly above medium degree. The table above display a quantitative evaluation result. The table above does not contain comments, what measures to implement to improve the model and knowledge learned during the evaluation interviews. This will be explained in the next subsection.

10.1.3 Evaluation by competency questions (QC)

”A models ability to answer a set of questions gives an indication of the competency of a model or how well it supports problem solving. Competency questions represent a set of tasks that arise in enterprise engineering and the requirements on the enterprise model that is required to represent the tasks and their solutions. These requirements are formulated as a set of questions that the model is required to answer. One of the advantages in using competency questions is that they can be informal questions that can be answered informally or they can be specified formally to provide a more precise evaluation of the model.” (80) The model (figure 9.1) is evaluated by asking the model (figure 9.1) directly by based in competency questions. See Appendix J. Table 10.1: Score model evaluation, the score for competency questions (QC).

10.1.4 Qualitative evaluation

Qualitative evaluation is presented in Appendix K.

10.2 SEQUAL

SEQUAL is a framework for quality of models based on semiotic theory (69). See figure 11.3 SEQUAL framework for discussing quality of models (69, p. 208) below.

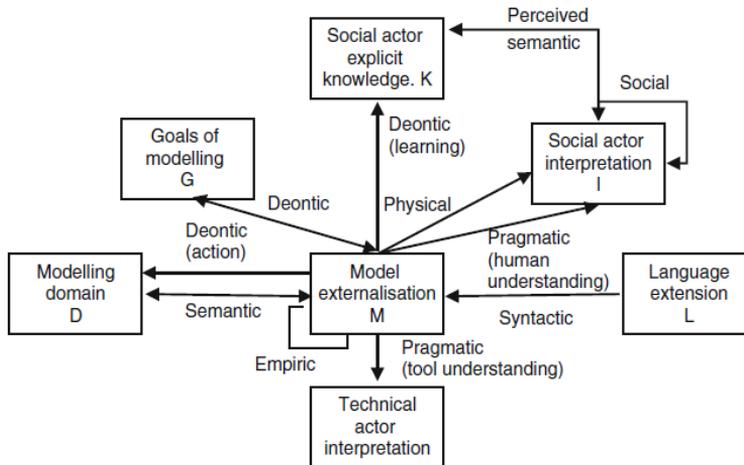


Figure 10.1: SEQUAL framework for discussing quality of models

Quality has been defined referring to to correspondence between statements belonging to following sets (69; 91):

- **G**, sets of goals of the modelling task.
- **D**, i.e., the set of all statements that can be stated about situation. The Goal of modelling typically restricts the domain to only those things relevant to achieve the goal.
- **L**, the language extension, i.e., what can be expressed by the modelling language used.
- **M**, the externalized model itself.
- **K**, the explicit knowledge that the audience (both modelers and model interpreters) have on the domain.
- **I**, the social actor (human) interpretation of the model.
- **T**, the technical actor (tool) of the model.

The main quality types are (69; 91):

- **Physical quality:** The basic quality goal it that the externalized model **M** is available to the relevant actors (and not for others) for interpretation (**I** and **T**).

- Empirical quality deals with comprehensibility of the model **M**.
- Syntactic quality is the correspondence between the model **M** and the language extension **L**. Is the language use correctly in the model?
- Semantic quality is the correspondence between the model **M** and the domain **D**.
- Perceived semantic quality is the similar correspondence between the social actor interpretation of the model **I** of a model **M** and his or hers current knowledge **K** of domain **D**.
- Pragmatic quality is the correspondence between model **M** and the actor interpretation (**I** and **T**) of it. Thus whereas empirical quality focus on if the model is understandable according to some objective measure that has been discovered empirically in e.g., cognitive science, we look on to what extend the model actually has been understood.
- The goal defined for social quality is agreement among social actor's interpretation of models.
- The deontic quality of the model relates to that all statements in the model **M** contribute to fulfilling the goals of modelling **G**, and that all the goals of modelling **G** are addressed through the model **M**.

10.3 Model evaluation by SEQUAL

Evaluation by interviewing model stakeholders and competency questions evaluates the whether the purpose of the model is meet. These evaluation methods do not necessarily provide an objective evaluation of the quality of the model. Therefore a more objective evaluation method as SEQUAL might useful evaluating the quality of the model represented by figure 9.1.

- **G**, sets of goals of the modelling task:
 - "To govern how decisions are made among stakeholders concerning integration at NTNU" (chapter 1.3).
 - After evaluation, "Create integration governance model for NTNU." (chapter 1.3).
- **D**, the domain i.e., the set of all statements that can be stated about the situation. The Goal of modelling typically restricts the domain to only those things relevant to achieve the goal. Domain **D**:
 - NTNU, refer to problem definition: "Study and evaluate how enterprise modeling and architecture improves integration governance at NTNU" (chapter 1.3).
 - TIA and FS, "Study TIA Case. Focus on FS, Common Student System" (chapter 1.3).
- **L**, the language extension, i.e., what can be expressed by the modelling language used.

- Archimate (Archi)
- Foundation of execution with modelling notation for Operation Model and Engagement model (20).
- **M**, the externalized model itself.
 - The model represented by figure 9.1 Foundation of execution based on best practice.
 - And the EA in figure 9.1 including modelling views supported by TOGAF presented in chapter 8. EA To-Be.
- **K**, the explicit knowledge that the audience (both modelers and model interpreters) have on the domain.
 - The modeler and model interpreters (the model stakeholders listed in chapter 10.1.1) have a comprehensive domain knowledge. Referring to their roles at NTNU.
- **I**, the social actor (human) interpretation of the model.
 - Referring to the stakeholders various roles and perspectives in the NTNU Organization listed in chapter 10.1.1.
- **T**, the technical actor (tool) of the model.
 - Referring to the stakeholders various listed in chapter 10.1.1. with technical background i.e. developer and system administrator.

The following evaluation qualities from SEQUAL are selected to evaluate the model represented by figure 9.1: Semantic and perceived semantic quality, syntactic quality and pragmatic quality.

10.3.1 Semantic and perceived semantic quality

Semantic quality was originally defined as correspondence between the model and the modelling domain (69, p. 227).

The modelling domain **D** is NTNU with focus on TIA (Service Oriented Information Architecture) and FS (Common Student System). This includes data source systems, services, data flow, involved processes, stakeholders and organization represented by EA To-Be supported by TOGAF in chapter 9. In addition the modelling domain is the foundation of execution best on best practice figure 9.1, the model **M** representing operation model, engagement model and EA To-Be. Stakeholders of the model have been interviewed (Appendix J) to find out if the model meets its purpose. The main purpose of the Integration Governance model is to govern how decisions are made among stakeholders concerning integration at NTNU (chapter 1.3). When referring to table 10.1, Score model Evaluation, all questions have an average score at medium or above except for Q5. This indicates that there is correspondence between the model and the modelling domain.

Validity

Validity mean that all statements made in the model are regarded as correct and relevant for the problem. M= Based on the interviews and table 10.1, Score model evaluation, the model tend to valid.

Completeness

Completeness means that the domain model all the statements which would be correct and relevant about the domain. D= Based on table 10.1: Score model evaluation and table 16.70, Qualitative evaluation, following issues might make the model incomplete:

- "The model and mindset is correct, however the terminology used in the model does not fit for NTNU. One must take a step further which is the organization map for NTNU, add a familiar language/terminology and then match it to the model." (?)
- "At a university it should be Anarchy. The model distinguish between research and administration to a small degree." (82) and "At NTNU, there is a lack of will to distinguish between administrative processes, research processes and education processes. The borderline between administration at one hand and research/education at the other hand is unclear." (82)
- "Referring to figure 9.1. The "Unification" corner fit for administration. Standardization is positive for administration and production. While standardization becomes a constraint for research, development and innovation and fit the into the "Coordination" corner of the model." (89)
- Q5 in table 10.1, Score model evaluation, has has average score below medium. Q5 concern about security and classification.

10.3.2 Syntactic quality

Syntactic quality is the correspondence between the model **M** and the language extension **L** of the language in the model in which the model is written (69, p. 223). Languages **L** selected are: Archimate (Archi) and Foundation of execution with modelling notation for Operation Model and Engagement model (20). Archi is applied for modelling EA As-Is (Appendix G) and EA To-Be (chapter 8). Foundation of execution notation is applied to model figure 9.1 representing the Best Practice Integration Model.

- Archi: As Archi has strict and well defined syntax and set of rules for which types of boxes and arrows that can be connected, the Archi notation or the Archi meta-model, it is up to the modeler to use that notation. For the modeler it is relatively easy to learn the Archi notation. If the modeller click on a box, symbol or arrow, a well described description appear. The strict and well defined syntax ensures the syntactic quality (63).
- Foundation of execution notation: Has well defined syntax and set of rules regarding which governance archetypes, decision types and operation models. I.e. there can be only one decision point per decision type but several input points (20). Please

note the notation for Enterprise Architecture (20) is not applied in the this thesis. Instead TOGAF and Archi notation is applied (Appendix G and chapter 8).

Syntactic invalidity

As Archi has strict and well defined syntax, syntactic invalidity depends on the context on the domain modelled (63). Example on syntactic invalidity is in figure 8.2 (TIA To-Be v03) the source systems displayed at infrastructure level (green) are represented in application level notation (blue). Another example of syntactic invalidity is figure 8.8 (Data ownership and service complexity). Both examples to achieve pragmatic quality. See pragmatic quality below. For Foundation of execution notation there is not any tool with meta model supporting the notation. This lacking tool support might increase the risk for syntactic invalidity.

Syntactic incompleteness

As Archi has strict and well defined syntax, syntactic incompleteness depends on the context on the domain modelled (63). For Foundation of execution notation represented by figure 9.1 there is a syntactic incompleteness in that is not clear or obvious for the user that the Enterprise model (EA) represents EA To-Be supported by TOGAF including several views in chapter 8.

Error prevention

Archi provide error prevention (63).
For Foundation of execution notation: Na

Error detection

Archi provide error detection (63).
For Foundation of execution notation: Na

10.3.3 Pragmatic quality

Pragmatic quality as defined relates to the comprehension of the model by participants (69, p. 231). Two aspects can be distinguished:

- That the human stakeholders of the model is correct relative what is meant to be expressed in the model. When interviewing the stakeholders for evaluation, relevant concepts related to the model was first presented. The presentation counted about 40 pages. The duration for the interview sessions including the presentation of concepts and the model figure 9.1 were about 1 to 1 and half hours. This indicate there is lot of information to perceive in a short time. I.e. "I can not take in all information when presenting the model in only one hour" (85). The model to be evaluated figure 9.1 includes the Enterprise Architecture (EA) based on best practice EA To-Be. Considering the interviewees short evaluation time and stakeholders various positions at NTNU it is understandable that the model is perceived differently. Still,

based on the table 10.1, Score model evaluation, and table 16.70, Qualitative Evaluation, it might be concluded that the model meet its purpose.

- That the tool interpretation is correct relative to what is meant to be expressed in the model. A challenge can be that the user find the concepts of the Foundation of Execution represented in figure 9.1 unfamiliar. I.e. "The model and mindset is correct, however the terminology used in the model does not fit for NTNU. One must take a step further which is the organization map for NTNU, add a familiar language/terminology and then match it to the model" (83). In addition the Archi modelling notation is not always applied as standard Archi notation. I.e. in figure 8.2 (TIA To-Be v03) the source systems displayed at infrastructure level (green) are represented in application level notation (blue). And in figure 8.8 (Data ownership and service complexity) different color codes represents source systems in services. In this manner the notation standard is broken to achieve a more pragmatic holistic view to support the implementation of the TIA system architecture in figure 8.2 and figure 8.8.

10.4 Model evaluation summary

Model evaluation methods applied are quantitative evaluation, competency questions, qualitative evaluation and the SEQUAL method.

10.4.1 Quantitative evaluation

Table 10.1, Score model evaluation, is based on model evaluation scores given by respondents in interviews (Appendix J). The scores given by the respondents are based on questions described in chapter 10.1.2 Quantitative evaluation. The questions aim to evaluate to what degree the model (figure 9.1) meet its purpose and the control questions aim to evaluate, to what degree the model (figure 9.1) provide a target picture for governance of integrations processes and to what degree the model (figure 9.1) fit to NTNU.

10.4.2 Competency questions evaluation

Competency questions (QC) score is described in table 10.1, Score model evaluation. "One of the advantages in using competency questions is that they can be informal questions that can be answered informally or they can be specified formally to provide a more precise evaluation of the model" (80). Questions applied are the identical to the questions applied for Quantitative evaluation in chapter 10.1.2. The difference is attempting to ask the model directly. Therefore competency questions (QC) score described in table 10.1 will be colored by my personal point of view.

10.4.3 Qualitative evaluation

Qualitative evaluation (Appendix K) is based in interviews reported in Appendix J. For each question the interviewee often had several interesting comments. And these comments

might provide more knowledge and insight in the model evaluation compared to the quantitative score in table 10.1, Score model evaluation. After a qualitative assessment the most relevant and interesting comments from the interviews (Appendix J) were collected in the table 16.70, Qualitative evaluation (Appendix K).

10.4.4 SEQUAL

Input for SEQUAL evaluation is the Problem description presented in chapter 1.3, the model represented by figure 9.1, table 10.1, Score model evaluation, (quantitative evaluation and evaluation by competency questions) and table 16.70 Qualitative evaluation (Appendix K). Evaluation by competency questions and qualitative evaluation is colored by my personal point of view. This will probably affect the SEQUAL evaluation as well. The following evaluation qualities from SEQUAL are selected to evaluate the model represented by figure 9.1: Semantic and perceived semantic quality, syntactic quality and pragmatic quality.

Integration Governance Model

This chapter presents the Integration Governance model for NTNU based on best practice Integration Governance model represented in figure 9.1 and adjustments post model evaluation conducted in the previous chapter.

11.0.5 Model incompleteness and adjustments

Chapter 11.1.1 Semantic and perceived semantic quality evaluate the model (figure 9.1) regarding model completeness. This subsection presents model adjustments for the Operation model, the Engagement model and Enterprise Architecture.

Adjusted Operation Model

Following statements indicates that the engagement model in represented in figure 9.1 best practice model are incomplete: The statements are below followed with adjustments of the operation model:

- "The model distinguish between research and administration to a small degree." (82) and "At NTNU, there is a lack of will to distinguish between administrative processes, research processes and education processes. The borderline between administration at one hand and research/education at the other hand is unclear." (82) Adjustment: The model should distinguish between administration and research (82). Administrative and education processes are placed the "Unification" operation model. See figure 11.1 below. This because Standardization is positive for administration and production (89). Education processes are placed in the "Unification" operation model under the assumption that education represent a production line for NTNU. In addition FS (Common Student system) (56) is defined as standard system for student administration by the Norwegian Ministry of Education.
- "Referring to figure 9.1. The "Unification" corner fit for administration. Standardization is positive for administration and production. While standardization becomes a

constraint for research, development and innovation and fit the into the "Coordination" corner of the model." (89) Adjustment: Based on the statements above, research processes must be separated from the "Unification" operation model and placed in the "Coordination" or "Diversification" operation model. See figure 11.1 below. This because standardization becomes a constraint for research, development and innovation (89).

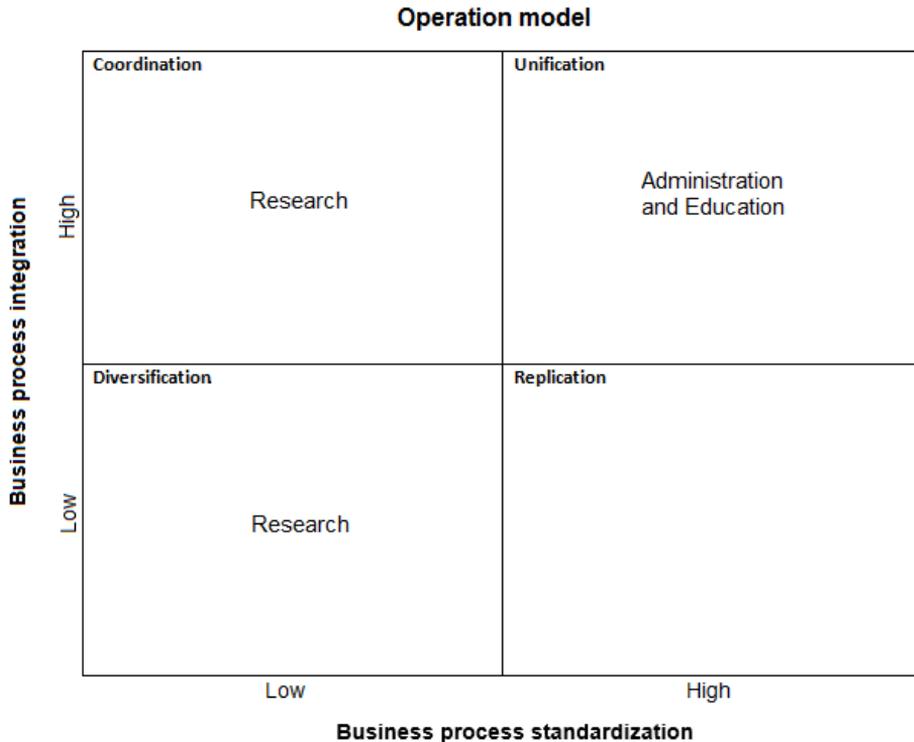


Figure 11.1: Adjusted NTNU Operation Model

In the above figure 11.1, Adjusted NTNU Operation Model, research processes are placed in the "Coordination" or "Diversification" operation model. It is not given that research processes should have process integration (Coordination). Additional comment from qualitative evaluation (Appendix K): "Anarchy archetype is often related to local IT supporting research and should not be standardized." (86) E.g:

- Lab experiments
- Cybernetic simulations
- Design
- Processing - geo data

Adjusted Engagement model

Following statements indicates that the engagement model in represented in figure 9.1 best practice model is incomplete: The statements are followed with adjustments of the engagement model:

1. "At a university it should be Anarchy. The model distinguish between research and administration to a small degree." (82) and At NTNU, there is a lack of will to distinguish between administrative between administration at one hand and research/education at the other hand is unclear" (82). In the adjusted NTNU engagement model below (figure 11.1) the Business applications decision type has been split in three decision types: Administrative applications, Research applications and Education application. This ease the distinction between administrative between administration at one hand and research/education at the other hand.
2. "The model and mindset is correct, however the terminology used in the model does not fit for NTNU. One must take a step further which is the organization map for NTNU, add a familiar language/terminology and then match it to the model" (83). In the adjusted NTNU engagement model below figure 11.2: Adjusted NTNU Engagement Model, the Governance Archetypes (23) are translated to NTNU context:
 - Business monarchy: = Top Management
 - IT monarchy: = IT Operations Committee
 - Feudal: = Faculty or Department Managers
 - Federal: = IT Arena for Line Managers (Division and Faculty level)
 - IT duopoly: = IT and Management (Top or Line)
 - Anarchy: = Local IT or isolated groups (Local IT meaning IT units under each faculty)

	IT Principles		IT Infrastructure		IT Architecture		Administrative Applications		Research Applications		Education Applications		IT Prioritization and Investment	
	Input	Decision	Input	Decision	Input	Decision	Input	Decision	Input	Decision	Input	Decision	Input	Decision
Top Management		v												v
IT Operations Committee			v	v	v									
Faculty or Department Management							v		v	v				
IT Arena for Line Managers	v					v	v					v	v	
IT and Management (Top or Line)			v				v				v			
Local IT or isolated groups			v						v		v			

Figure 11.2: Adjusted NTNU Engagement Model

In figure 12.1 above if comparing Administrative applications and Research applications decision types the decision input and decision points are diversified. Decisions regarding Research Applications are based on Local IT or isolated groups (Anarchy) and Faculty or Department Managers (Feudal) representing autonomy (20). And decisions regarding

Administrative Applications are mainly based decisions from IT Arena for Line Managers (Federal) representing standardization (20).

Adjusted Enterprise Architecture

Following statements indicates that the Enterprise model in represented in figure 9.1 best practice model is incomplete. The statements are followed with adjustments of the Enterprise Model and Architecture To-Be (chapter 8):

1. "One must take a step further which is the organization map for NTNU" (83). Organization map is adjusted in chapter 8, EA To-Be in figure 8.4.
2. Q5 in table 10.1: Score model evaluation has an average score below medium. Q5 concern about security and classification. To adjust concerning security and classification a decision model figure 8.9, Improved model for security and classification of information, has been added in Chapter 8, EA To-Be.

11.0.6 NTNU Integration Governance Model

NTNU Foundation of Execution (figure 11.3) below model is based on best practice Foundation of Execution (figure 9.1) and is adjusted for incompleteness found in model evaluation in chapter 10. NTNU Foundation of Execution (figure 11.3) defines the NTNU Integration Governance Model.

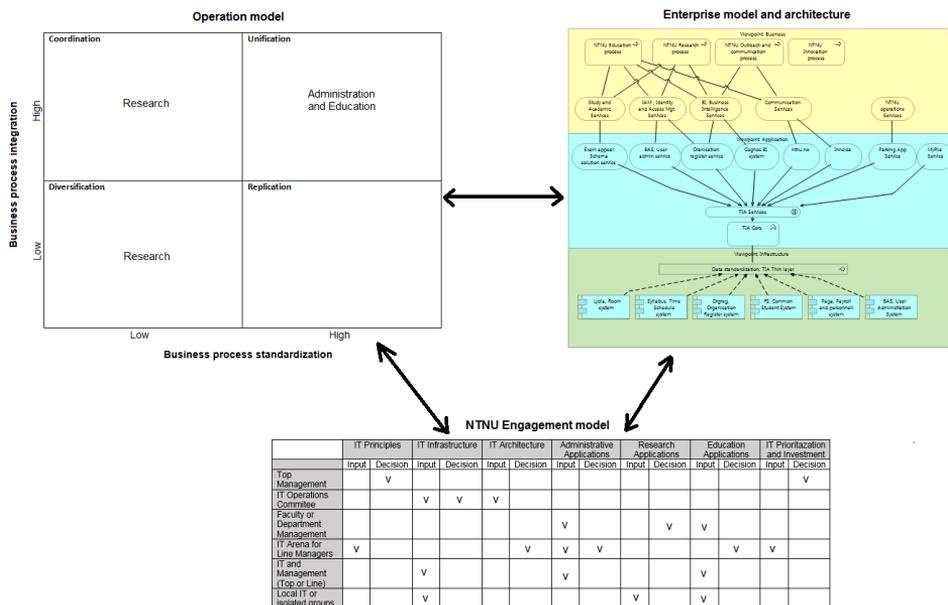


Figure 11.3: NTNU Integration Governance Model

Chapter 12

Implementation steps

This chapter presents proposed implementation steps for implementing an Integration Governance model for NTNU. The Integration Governance model for NTNU is represented by figure 12.3. The proposed implementation steps are divided in the operational level, the tactical level and the strategic level.

12.0.7 Proposed Implementation steps

The proposed implementation steps are based on external survey interviews (Appendix B), conversations (Appendix H), gap analysis (chapter 9.3) and model evaluation (chapter 10). Gap analysis and model evaluation are both colored by colored by personal point of view. This will influence the proposed implementation steps chosen. Stakeholders of the NTNU Integration Governance model (figure 11.3) are represented at strategic, tactical and operation level. Therefore the proposed implementation steps must be addressed to the correct level. The strategic level it is addressed to the top and strategic management at the NTNU organization, tactical level it is addressed to the management at the NTNU IT Division and operational level is addressed to the operational management related to integration at the NTNU IT Division.

12.0.8 Operational level implementation steps

”The degree of standardization of business processes I can not govern at my level. However I can Influence the degree of integration. NTNU fit in the Coordination operation model referring to figure 9.1. E.g. I cannot standardize the HR process and I am not sure if the Rector can do it either” (2). What kind of measures can be influenced at the operational level? Implementation steps at the operational level are measures that do not need to be addressed at a higher level (tactical and strategic) and that can be implemented in a relative short period.

The following operational level implementation steps are proposed based on chapter

9.3 Gap analysis, chapter 10 Model evaluation and interviews
(Appendix C and Appendix J):

1. Integration Governance best practice principles (chapter 8.1.1):
 - (a) *Enhance business process standardization and integration:*
Enhance business process integration. (Business process standardization can not be influenced at operational level (88)).
 - (b) *There should be a forum where data and process owners interact:*
Implement integration and data flow forum as a start: Coordination of issues regarding the integration of the information objects from source systems (72).
 - (c) *Architecture frameworks as TOGAF or guidelines implemented or TOGAF guidelines are applied:*
Build Enterprise model related to TIA and its source and target systems. Continue work started in EA As-is (Appendix G) and EA To-Be (Chapter 8). Documenting the architecture for TIA, NTNU integration and data flow domain.
 - (d) *Decisions must follow guidelines and defined IT-Governance structure:*
Define an engagement model at operational level: Who is responsible for taking which decisions at operational level? This is as a start Point!
 - (e) *The IT system shall not pass the border for the business process:*
Advocate this principle.
 - (f) *Describe information models and master data models for the most important information objects:*
Build information models and master data models.
2. Interviews (Appendix B and Appendix J):
 - (a) **Implement** security and classification model (89) (figure 8.9)
 - (b) **Consider** Center of Excellence. Referring to best practice at Sykehuspartner (33).
 - (c) **Consider** DevOps organization of Data flow/TIA team. Referring to best practice at Statoil (32).

12.0.9 Tactical level implementation steps

Following tactical level implementation steps are proposed based on gap analysis (chapter 9.3) and model evaluation interviews:

1. Integration Governance best practice principles (chapter 8.1.1):
 - (a) *Architecture frameworks as TOGAF are ether implemented or TOGAF guidelines are applied:*
Implement TOGAF Framework. The TOGAF implementation is started, however it is far from complete as reported in chapter 5.2.

-
- (b) *Decisions must follow guidelines and defined IT-Governance structure (engagement model):*
Define engagement model for strategic (top) management as input to an IT policy for NTNU (49).
 - (c) *There should be a forum where data and process owners interact:*
Define mandate for integration and data flow forum (72).
 - (d) *The IT system shall not pass the border for the business process:*
Define as input to an IT policy fro NTNU
2. Business Silos architecture (chapter 8.9.2):
 - (a) **Improve** business case analysis.
 3. Standardized Technology architecture (chapter 8.9.2):
 - (a) **Implement** A formal architecture compliance process.
 - (b) **Implement** Architects on project teams.
 - (c) **Implement** An architecture exception process.
 - (d) **Implement** A formal research and adoption process.
 4. Business Modularity architecture (chapter 8.9.2):
 - (a) A formal research and adoption process.
 5. Interviews (Appendix C and Appendix J):
 - (a) **Define** integration standards with the purchasing/procurement department. "The purchasing/procurement department must be coordinated regarding standards. Routines for purchase/procurement must be in place in such a way that it is possible to integrate new systems" (85)
 6. **Define** practice Integration Governance principles as input to IT policy (49) for NTNU.

12.0.10 Strategic level implementation steps

Following strategic level implementation steps are proposed based on gap analysis (chapter 9.3) and model evaluation interviews:

1. Integration Governance best practice principles (chapter 8.1.1):
 - (a) *Enhance business process standardization and integration:*
Define as input to strategy or an IT policy for NTNU.
Define for the operation model for NTNU. NTNU Governance Model (figure 11.3) defines "Unification" operation model for administrative and education processes and research processes for "Coordination" or "Diversification" operation model.

- (b) *Strategy and vision for the enterprise and IT anchored:*
Define an IT strategy or IT policy for NTNU.
 - (c) *There should be a forum where data and process owners interact:*
Implement an arena for data and process owners to interact to enhance standardization and integration (decision model (23)).
 - (d) *Decisions must follow guidelines and defined IT-Governance structure:*
Define IT-Governance structure and engagement model based on input from tactical level.
2. Standardized Technology architecture (chapter 8.9.2):
- (a) **Implement** Centralized funding of enterprise applications.
 - (b) **Implement** A centralized standards team
3. Optimized Core architecture (chapter 8.9.2):
- (a) **Implement** Enterprise wide process owners.
 - (b) **Implement** A statement of enterprise architecture guiding principles.
 - (c) **Improve** Business leadership of project teams.
 - (d) **Implement** Senior executive oversight of enterprise architecture.
4. Business Modularity architecture (chapter 8.9.2):
- (a) **Improve** Post implementation assessment regarding programs and projects regarding ROI (Return on investment).
 - (b) **Improve** A full-time enterprise architecture team.

Chapter 13

Analysis and discussion

This chapter analyze and discusses the main hypotheses for this thesis presented in chapter 1.4 related to Model evaluation in chapter 10 and Integration Governance best practice analysis in chapter 4. Each hypothesis is assessed in relation to the results. And a conclusion for each hypothesis is stated.

13.1 Hypothesis discussion

This section discusses the hypotheses for this thesis presented in chapter 1.4.

13.1.1 H1: The main hypothesis: Enterprise Modeling and Architecture improves Integration Governance

The best practice model is represented by figure 9.1. The model is based on the concept Foundation of Execution presented in chapter 2.6. which consist of: The Operation Model, The Engagement Model and the Enterprise Architecture (EA). The model is represented by figure 9.1. is in chapter 9 defined as best practice for Integration Governance. Please notice that enterprise modeling and architecture is a part of the best practice Integration Governance model represented by figure 9.1. The model (figure 9.1) indicates mutual dependencies between the operation model, enterprise model/EA To-Be and the IT Engagement Model.

First in the chapter 9.1.5 (How does the EA To-Be and the Engagement Model affect each other?) there is an indication of that Enterprise Modelling and Architecture improves Integration Governance: "To be able to perform the right decisions EA To-Be represents the detailed map of the enterprise at component level to guide its changes."

Second there is an additional indication of that Enterprise Modelling and Architecture improves Integration Governance in chapter 9.1.5: "For the NTNU Schema Solution

project an implemented EA To-Be and and implemented Engagement model the consequence would be: Decision makers will have an a ability to see the requirements for a Schema Solution from an Enterprise perspective.”

Finally the model evaluation conducted in chapter 10 by the evaluation score in the table 10.1 indicates that enterprise modeling and architecture improves Integration Governance. For Q7 in table 10.1: ”Does the model (figure 9.1) provide a target picture for governance of integrations processes” the average score is 3.4 of (1-5). And for Q8 in table 10.1: ”Does the model (figure 9.1) fit to NTNU?” the average score is 3.3 of (1-5). In addition a statement from the model evaluation interviews is interesting: ”The model and mindset is correct, however the terminology used in the model does not fit for NTNU. One must take a step further which is the organization map for NTNU, add a familiar language/terminology and then match it to the model” (83)

There are three indications reported above that Enterprise Modelling and Architecture improves Integration Governance in this thesis. However, this can not be finally concluded. It is reasoned by:

1. Best practice is based on surveys conducted (Appendix B) at only 7 external enterprises. The statistical basis is to small.
2. Model evaluation is based on 10 interviews (Appendix J). The statistical basis is to small as well.

Conclusion H1: Enterprise Modeling and Architecture improves Integration Governance? There are indications. Because of small statistical basis H1 can not be finally concluded in this thesis.

13.1.2 H2: There is a best practice for Integration Governance

A best practice is defined by the ”Unification” operation model in figure 3.2. and in literature (20). After the surveys (Appendix B) where conducted Integration Best practice analysis (chapter 4) characterize three enterprises in the ”Unification” operation model (figure 4.1). A question arised: ”How can I assume that the three enterprises in the Unification operation model box actually holds a best practice?” (1, p. 35). The table 4.1: Survey score, indicate that the best practice enterprises has a best practice at all levels: Strategic, tactical and operational. An exception is Statoil at tactical level in table 4.1. Table 4.1 indicate that there is a correlation between strategic, tactical and operational score. From my point of view an interesting observation is the standard deviation at tactical level in table 4.1. The practice at tactical level has the largest variation. This indicate from table 4.1 it is the practice at tactical level in an enterprise that make the most impact. Can it be concluded that there is a best practice for Integration Governance? Yes, there is an indication. However, best practice is based on surveys conducted (Appendix B) at only 7 external enterprises. Again the statistical basis is to small.

Conclusion H2: There is a best practice for Integration Governance? There are indications. Because of small statistical basis H2 can not be finally concluded

in this thesis.

13.1.3 H3: IT-operations practice influence Integration Governance practice to a less degree

The table 4.1: Survey score has a relative small operational standard deviation score (1,69). This also relative to the tactical standard deviation score (7,02). From my point of view this indicate that the operational practice influence Integration Governance practice to a less degree. And in my opinion this indication confirms the following statement: "The problem with our efforts to understand IT architecture was that the level of analysis was all wrong. The focus needs to be higher on enterprise architecture, the organizing logic for core business processes and IT infrastructure reflecting the standardization and integration of a company's operating model" (20). And in my opinion this indication confirms figure 2.6: IT Governance vs. IT Management as well. Meaning that IT Governance and IT Management are almost completely two distinct disciplines.

Conclusion H3: IT-operations practice influence Integration Governance practice to a less degree? There is an indication. Because of small statistical basis H3 can not be finally concluded in this thesis.

Chapter 14

Summary

This chapter presents the summary of this report. It aim to summarize the activities related to the Problem description in chapter 1.3. In the section for problem description below the main activities are presented with regards to accomplishment and the contributions from the author of this master thesis is marked: "contribution from author".

14.1 Problem description

The problem description is based on the assignment and described in chapter 1.3:
Through the master thesis the student shall study and evaluate how Enterprise modeling and Architecture improves integration governance at NTNU supported by TOGAF. Case to be studied is TIA (Service Oriented Integration Architecture at NTNU). The student also shall research best practice for Integration Governance at comparable enterprises. By comparing and analyzing best practice with TOGAF and improvements identified by Enterprise modeling the student shall propose an Integration Governance model for NTNU and steps for implementation.

This necessitates following main activities:

1. *Literature study and study of relevant NTNU internal documents:*
 - (a) Concepts found in the literature study are defined in chapter 2: Definition of Concepts. And the literature is referenced in the Bibliography. The concept Integration Governance is defined and introduced in chapter 2 and is an contribution from author.
 - (b) Relevant NTNU internal documents are referenced in the Bibliography.
2. *Study TIA Case. Focus on FS, Common Student System:*
 - (a) The TIA case and FS are described in chapter 6.

- (b) TIA and FS case are analyzed in Appendix G, Enterprise Model and Architecture As-Is and in chapter 8: Enterprise Model and Architecture To-Be.

3. *TIA analysis supported by TOGAF:*

- (a) TIA As-Is is analyzed in Appendix G, Enterprise model and Architecture As-Is (contribution from author). And following TOGAF phases are described:
 - Preliminary Phase
 - A - Architecture Vision
 - B - Business Architecture
 - C - Information Systems Architecture
 - D - Technology Architecture
- (b) TIA To-Be is analyzed in chapter 8: Enterprise model and Architecture To-Be (contribution from author). And following TOGAF phases are described:
 - Preliminary Phase
 - A - Architecture Vision
 - B - Business Architecture
 - C - Information Systems Architecture
 - D - Technology Architecture
 - E - Opportunities Solutions
 - F - Migration Planning
 - G - Implementation Governance
 - H - Architecture Change Management

4. *Create Enterprise model and Architecture. Architectural artifacts such as:*

- *Information model:*
 - Information model is described chapter 8.4.3 Information Model. The most important information objects is FS (Common Student System) and their relations are described. In addition figure 8.9, TIA-FS Information Model, visualize how the FS information objects are applied in different contexts. These are contributions from author.
 - The information model is based on regulations referring to the Act relating to Universities and University Colleges of 1 April 2005, no. 15 (71).
- *Security and classification of information:*
 - NTNU Information Security Policy and Principles is described in chapter 8.1.3. visualized by figure 8.3: Information Classification and Security Levels.
 - A security and classification model is described in figure 8.9 Improved model for security and classification of information. This model is a contribution from author. And this model is introduced post evaluation.

5. *Enterprise model and architecture:*

- (a) Enterprise model and architecture is created, supported with TOGAF, are created in Appendix G, Enterprise Model and Architecture As-Is (contribution from author) and chapter 8: Enterprise Model and Architecture To-Be (contribution from author).
 - (b) Best practice Integration Governance model (figure 9.1) based on Foundation of Execution including Operation Model, Enterprise Architecture (EA) and IT engagement model, represented by figure 9.1, is an enterprise model and architecture created with different architectural views compared with TOGAF expressing similar and overlapping architectural structures.
 - (c) Model development and testing is described in Appendix I (contribution from author).
 - (d) List of architectural artifacts is presented in Appendix L (contribution from author).
6. *Conduct best practice surveys at minimum three comparable enterprises:*
- (a) Questionnaire attempting to find best practice for Integration Governance in described in Appendix A (contribution from author).
 - (b) Reasoning behind questionnaire is described in chapter 3 Integration Governance best practice survey (contribution from author).
 - (c) External surveys conducted to find Integration Governance best practice is described in Appendix B (contribution from author). Three comparable enterprises was characterized having a best practice by high degree of business process standardization and high degree of business process integration ("Unification" operation model). This expressed in figure 4.1 Enterprise operation model categorization (contribution from author).
 - (d) Internal NTNU surveys conducted to find actual NTNU Integration Governance best practice is described in Appendix C (contribution from author).
7. *Best practice analysis:*
- (a) Best practice analysis is described in chapter 4 Integration Governance best practice analysis (contribution from author).
 - (b) Appendix D compares the 3 best practices represented by Statkraft, Sykehuspartner and Statoil (contribution from author).
 - (c) Appendix E contains a qualitative analysis of the best practice enterprises comparison of Sykehuspartner, Statoil and Statkraft (contribution from author).
 - (d) Chapter 13 Discussion, assess thesis hypothesis 2, H2: There is a best practice for Integration Governance (contribution from author).
8. *Align best practice analysis with Enterprise model and Architecture:*
- (a) Best practice is applied in chapter 8: Enterprise Model and Architecture To-Be (contribution from author).

- (b) Chapter 9: Foundation of Execution and gap analysis, aim to align Enterprise Model and Architecture To-Be with foundation execution for NTNU based on best practice. And it aim to present gap analysis based on actual practice and best practice (contribution from author).

9. *Evaluation:*

- (a) Evaluation is conducted in chapter 10 Model Evaluation (contribution from author).
- (b) Evaluation methods conducted are: Quantitative and qualitative evaluations based on interviews, evaluation based on Competency questions and evaluation by the SEQUAL method (69).
- (c) Evaluation interviews are described in Appendix J (contribution from author).
- (d) Qualitative evaluation is described in Appendix K (contribution from author).
- (e) The SEQUAL evaluation in this thesis contain following perspectives:
 - Semantic and perceived semantic quality
 - Syntactic quality
 - Pragmatic quality

10. *Create Integration Governance model for NTNU:*

- (a) Integration Governance Model for NTNU, represented by figure 11.3, is described in chapter 11 Integration Governance model (contribution from author).
- (b) The NTNU Integration Governance model (figure 11.3) in based on best practice Integration Governance model (figure 9.1) adjusted after evaluation conducted in chapter 10 Model Evaluation.

11. *Propose steps for implementation of Integration Governance at model at NTNU:*

- (a) Chapter 13: Implementation steps, proposes implementation steps for implementing Integration Governance model for NTNU (contribution from author).
- (b) The implementation steps are based on chapter 9.3 Gap analysis, chapter 10 Model evaluation and interviews (Appendix C and Appendix J).

Expected outcome is an Integration Governance model for NTNU. The main purpose of the Integration Governance model is to govern how decisions are made among stakeholders concerning integration at NTNU.

- Integration Governance Model for NTNU, is represented by figure 11.3, described in chapter 11 (contribution from author).
- The purpose of the model is evaluated in chapter 10 Model evaluation (contribution from author).

Chapter 15

Further work

Further work is divided in two categories: Academic work and work for the principal the NTNU IT Division described in chapter 12 Implementation steps.

15.1 Further academic work

This section suggests three future task that will improve the work related to this thesis:

1. Write an scientific article based on hypothesis H1 described in chapter 1.4 in this thesis.
H1: "Enterprise Modeling and Architecture improves Integration Governance."
Hypothesis H1 should studied and elaborated further. The thesis contain considerable numbers of data in which should be further analyzed. A draft for a scientific article based on hypothesis H1 is presented in Appendix M.
2. Write an scientific article based on hypothesis H2 described in chapter 1.4 in this thesis.
H2: "There is a best practice for Integration Governance."
Hypothesis H2 should studied and elaborated further. This thesis contain considerable numbers of data in which should be further analyzed for H2 as well.
3. In chapter 13: Discussion, the hypotheses H1, H2 and H3 have indications of validity. However, the hypotheses can not be finally concluded. This reasoned by lack of statistical basis. A measure to provide a sufficient statistical basis should be executed. The surveys based on questionnaire in Appendix A should be at large scale, automated (35) and distributed to an substantial number of enterprises. With a sufficient statistical basis it might be possible to conclude the validity of hypotheses H1, H2 and H3.

15.2 Further work for the NTNU IT Division and NTNU

Further work for the NTNU IT Division is described in chapter 12: Implementation steps. The proposed implementation steps are divided into three levels: Operational, tactical and strategic level.

1. Further work operational level:

Chapter 12.0.6: Operational level implementation steps, represent a relative short time horizon implementation phase. And it is addressed to the operational management related to integration at the NTNU IT Division.

2. Further work tactical level:

Chapter 12.0.7: Tactical level implementation steps, represent a relative medium time horizon implementation phase. And it is addressed to the management at the NTNU IT Division.

3. Further work strategic level:

Chapter 12.0.8: Strategic level implementation steps, represent a relative long time horizon implementation phase. And it is addressed to the top and strategic management at the NTNU organization.

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Chapter 16

Appendices

- Appendix A: The questionnaire
- Appendix B: External enterprise surveys
- Appendix C: NTNU internal surveys
- Appendix D: Comparison of the 3 best practices
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- Appendix N: Statoil Governance document: IT Components

Appendix A

This appendix contains questionnaire to find best practice for Integration Governance. Questions are divided in three levels: Strategic, tactical and operational level.

16.1 Questionnaire

Strategic level (operation model)

1. Do the enterprise have shared customers and suppliers?
(global or across the organization)
 - a. Shared
 - b. Local or global
 - c. Few shared customers and suppliers
 - d. Few, if any shared customers or suppliers

2. Transactions
 - a. Impact on other business unit transactions
 - b. Globally integrated business processes transactions, often with support of enterprise systems
 - c. Independent transactions
 - d. Independent transactions aggregated at a high level

3. Business units and operations
 - a. Operationally unique business units or functions
 - b. Business units with similar or overlapping operations
 - c. Operationally unique business units
 - d. Operationally similar business units

4. Management
 - a. Autonomous business management
 - b. Centralized management often applying functional/process/business unit matrices
 - c. Autonomous business management
 - d. Autonomous business unit leaders with limited discretion over processes

5. Design of business processes
 - a. Business unit control over business process design

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- b. High-level process owners design standardized processes
 - c. Business unit control over business process design
 - d. Centralized (or federal) control over business business process design

6. Sharing of data

- a. Shared customer/supplier/product data
- b. Centrally mandated databases
- c. Few data standards across business units
- d. Standardized data definitions but data locally owned with some aggregation corporate

7. IT-decisions

- a. Consensus processes for designing IT infrastructure services; IT application decisions made in business units
- b. IT decisions made centrally
- c. Most IT decisions made within business units
- d. Centrally mandated IT services

8. Operational model

- a. To what degree is business processes standardized? (High or low)
- b. To what degree is integration applied in the enterprise? (High or low)

9. Is there a strategy and vision for the enterprise?

- a. Is it anchored?

10. Is there a strategy and vision for IT?

- a. Is it anchored?

11. Is there a red line from strategy to operations?

12. What gives input to strategic management of IT?

Tactical level

1. What frameworks are implemented? Eg. ITIL, COBIT or TOGAF

- a. To what degree?
- b. What is the experience with these frameworks?

2. What is the core enterprise processes?

- a. What core enterprise processes is supported by integrations?

-
3. What IT-decision model is implemented?
 - a. Related to programs or projects?
 - b. Related to IT-operations and change

 4. Who own the processes?

 5. Who own the data?
 - a. Is the ownership clearly defined?

 6. Which stakeholders exist for the core processes?

 7. Organization(s). How does these stakeholders interact? (data and process owners)
 - a. Roles and responsibility regarding data, processes and integration
 - b. What what is responsibility for those roles regarding change for:
 - Process
 - Application
 - Technology

 8. IT portfolio management?
 - a. Regarding programs/projects
 - b. Regarding IT-operations and change

 9. Portfolio management and life cycle for systems
 - a. Life cycle cost for core systems supporting core enterprise processes?
 - b. Life cycle status: System, product, solution or component in or out?

 10. Target architecture, road map and gap analysis?

 11. Target governance model?

 12. Do You have development and governance teams?

 13. Programs for SOA and Governance training/education?
 - a. If so, how?

 14. Process transition plan?
-

-
15. Technology transition plan?
 16. Organization transition plan?
 17. Risk management/security? What framework or standard?
 - a. Is it followed?
 18. Has transition to new integration technology as SOA, Enterprise Architecture and IT-Governance lead to increased agility and opportunities to develop new services and products. Ie. increased competitiveness and shorter time-to-market?
 - a. In that case. To what degree?
 19. Do you have an information model?
 - a. What does it describe?
 - b. Are concepts defined? Such as a sale?
 20. Master data model?
 - a. What does it describe?
 21. Governance documents describing:
 - a. Architecture principles? In that case, which?
 - b. Architecture requirements regarding purchase, procurement or development?
 - c. Integration requirements?
 - d. Policy regarding legacy/technical dept?
 22. Price model
 - a. General price model for IT-services?
 - b. Price model for information/data-transactions/web-services?
 23. Governance
 - a. Tender and contracts?
 - b. How are enterprise processes, IT-systems and integration associated?
 - c. Who receive process change suggestions or initiatives?
 - d. Does one distinguish enterprise (what is done) and organization (who does)?
 24. What law or legislation are guidelines for information and integration?

Operational Level

1. Organization divided in development and IT-operations?
2. Classification of information and security?
3. Principles for integration?
 - a. Requirements for integrations? Such as SOA principles.
 - b. Requirements for software integrations?
 - c. Which types of integration methods are performed? And at what level? [ref 16. k1.4]
 - Data integrations, such as ETL?
 - Integrations at application level
 - Process integrations, such as work flow?
 - GUI integrations, such as portals?
 - d. Run time dependencies such as database link?
 - e. Business Intelligence. Data flow from local data warehouse to corporate data warehouse?
4. Framework for IT-operational processes such as ITIL?
 - a. Incident?
 - b. Change?
5. Revision control, building and distribution of software?
 - a. Code repository such as Git or Subversion?
 - b. Building such as Maven?
 - c. Operations and software distribution such as Cfengine or Microsoft SCCM?
6. What type of IT-operations take most resources and energy?
7. Re-active or pro-active IT operations?
8. Ownership to larger IT-services? Who?

Appendix B

External enterprise surveys External enterprise surveys interviewing:

1. University of Oslo/USIT: Mathias Meisfjordskar, Senior Engineer
2. CIO for a large commercial supplier of IT infrastructure and IT services
3. Statkraft, Knut-Olav Traa, Section Manager Integration
4. Sykehuspartner: Morten Vaagen, Section Manager Architecture and Jarle Boland, responsible for The Integration Factory
5. Hemit: Frode Junge, team manager integration development/IT-operations and Brd Grdem team manager architecture
6. IT-operations for bank, Senior Consultant
7. Statoil, Harald Wesenberg, Leading Advisor Solution Architecture

Interviews conducted for strategic, tactical and operational level. The Best Practice External survey is based on Questionnaire (Appendix A)

16.2 Interview with Mathias Meisfjordskar, USIT

USIT supports the University of Oslo, UIO. main areas of commitment: research, education and applied knowledge. USIT is also a Norwegian national center of competency in IT for the higher education sector (92).

Mathias Meisfjordskar, USIT, Senior Engineer: 29. October 2014
Email: mathias.meisfjordskar@usit.uio.no

Question no.	USIT strategic level answers	Score
1	a	1
2	a	1
3	a and c	1
4	c	1
5	Dont know	0
6	d	1
7	c	1
8a	Low	1
8b	High	1
9	Yes	1
9a	Yes	1
10	Yes	1
10a	Yes	1
11	Yes, however it is thin	0,5
12	As-is: It is very chaotic. To-be: Want to have more concrete frames.	0,5
	Strategic level score	13

Table 16.1: USIT strategic level survey

Question no.	USIT tactical level answers	Score
1	None	0
1a	Na	0
1b	Na	0
2	Research and education	1
2a	Research to a less degree, education to a larger degree.	1
3	Federal decision model, top-heavy	1
3a	Feudal	1
3b	Professional department	1
4	Professional department, result of service orientation of the central administration. Federal?"	1
5	Professional department, Federal	1
5a	For core systems, yes. For all other systems, no.	1
6	Strong influence by faculties. The entire enterprise (Faculties+administration) is represented in SCAIT. Faculty directors..	1
7	SCAIT, operative since 2012. Recommended January 2012.	1
7a	This is delegated to the professional departments such as: Enterprise and Economy Management, Academic Administration and Personnel support.	1
7b Process	Professional departments	1
7b Application	Professional departments	1
7b Technology	Professional departments	1
8	To some degree.	0,5
8a	To some degree.	0,5
8b	To some degree. IT-operations budget is now included in project budget.	1
9	To some degree. Good for core systems such as FS (Common Student System).	1
9a	FS	1
9b	No	0
10	Work started..	0,5
11	Yes. At strategic level it is good. Partly at lower levels.	1
12	Yes, for development. To-be for governance team.	1
13	No	0
13a	-	0
14	Dont know	0
15	Lacking, some have it..	0,5
16	Yes	1
17	IT-security handbook	1
17a	To some degree.	0,5

Table 16.2: USIT tactical level survey

Question no.	USIT tactical level answers	Score
18	Is in a transition-phase.	1
18a	In a to-be situation, definitely.	0
19	No, some work started.	0
19a	-	0
19b	Na	0
20	No, some work started, driven by business side..	0,5
20a	Na	0
21a	Under development	0,5
21b	Under development	0,5
21c	Under development	0,5
21d	No, but we have technical dept.	0
22a	Partly	0,5
22b	No	0
23a	Yes	1
23b	Lack of association between business and IT.	0
23c	Professional departments	1
23d	Yes, service orientation in the central administration.	1
24	Privacy Act (Personvernloven)	1
	Tactical level score	31

Table 16.3: USIT tactical level survey (continues)

Question no.	USIT operational level answers	Score
1	Yes, however in practice this divide is somewhat fuzzy.. (plan and practice..)	1
2	To some degree. Eg. Some research communities require extremely secure environments. Such as TSD: Services for sensitive data, an USIT project.	1
3	To-be	0
3a	To-be	0
3b	To-be	0
3c Data	Yes, numerous. Eg. File copy and relocation	1
3c Application	Few	0,5
3c Process	Lacking, there are some..	0,5
3c GUI	Some	0,5
3d	Yes, numerous	1
3e	Centralized	1
4	Lacking..	0,5
4a	Na	0
4b	Na	0
5	Yes, USIT is clever at this..	1
5a	Git and Subversion	1
5b	Partly	1
5c	Yes, both. There are big roll outs or releases..	1
6	Can?t answer	0
7	Both	1
8	Professional departments	1
	Operational level score	12,5

Table 16.4: USIT operational level survey

Further comments from Mathias Meisfjordskar during interview:

1. The questions asked where very relevant
2. There has been a change in the budget or finance model:
 - Frame budget model for IT-infrastructure
 - For projects there are also budgets for IT-operations. This to make an incentive for professional departments to take responsibility and make changes necessary and enhance innovation.
3. An important official IT-governance principle at UIO and USIT is: Decisions should be made at the lowest possible level. This principle is decided by the University director at UIO.
4. Centralized model (93) for integration?

-
5. USIT has a hybrid decision model (93).
 6. There is a lack of a tactical decision link.
 7. There is a lack of understanding what a business decision is and what an IT decision is.
 8. Mathias had defined a concept called: Access Manager (94).

Question:

Is it OK to publish answers?

- Answer: Yes

16.3 Interview with CIO for a large commercial supplier of IT infrastructure

A large commercial supplier of IT infrastructure, CIO: 30. October 2014

This interview is depersonalized at the CIO's request.

Email: depersonalized

Question no.	IT Supplier strategic level answers	Score
1	c	1
2	d	1
3	b	1
4	b	1
5	b	1
6	a	1
7	c and d	1
8a	Low, moving towards b	1
8b	Low, moving towards b	1
9	Yes	1
9a	Yes	1
10	Yes	1
10a	Yes	1
11	Yes	1
12	Sales management team for sale. Service management team for services. Managers in business unit matrices.	1
	Strategic level score	15

Table 16.5: IT Supplier strategic level survey

Question no.	IT Supplier tactical level answers	Score
1	None, looking at TOGAF	0
1a	Na	0
1b	Na	0
2	Marketing/sales, logistics, service delivery and economy/administration/support	1
2a	all	1
3	Federal	1
3a	-	0
3b	-	0
4	Business unit matrices management team	1
5	Different business units as: Marketing/sales own the Customer data	1
5a	No	0
6	Region directors P/L (Profit/loss)	1
7	Business unit matrices management team. Challenge: Customers and sales. Economy unit must sometimes re-invoice a delivery. Not good.	1
7a	Business unit matrices management team	1
7b Process	Business unit matrices management team i cooperation with internal IT	1
7b Application	Internal IT	1
7b Technology	Infrastructure	1
8	No	0
8a	Na	0
8b	Na	0
9	Yes	1
9a	Yes	1
9b	No	0
10	No	0
11	Yes	1
12	Yes, development is hired. There is a governance function, not team.	1
13	For SOA, yes. Not for Governance	1
13a	ERP-platform (SAP) model and framework	1
14	No	0
15	Yes, technical	1
16	Yes, should be more clear and better communicated.	1
17	ISO 27001/2	1
17a	Yes	1
18	Yes	1
18a	To some degree.	1
19	Not much	0
19a	Na	0
19b	Na	0
20	Yes	1
20a	Blank	0

Table 16.6: IT Supplier tactical level survey

Question no.	IT Supplier tactical level answers	Score
21a	Yes, but old	1
21b	Yes	1
21c	Yes	1
21d	No	0
22a	Model for cost allocation. Large share of fixed cost.	1
22b	No	0
23a	For IT-side, yes.	1
23b	Sales management team and Business unit matrices management team.	1
23c	Business unit matrices management team	1
23d	Sales management team and Business unit matrices management team.	1
24	Dependent on customer.	1
	Tactical level score	33

Table 16.7: IT Supplier tactical level survey (continues)

Question no.	IT Supplier operational level answers	Score
1	Yes	1
2	Yes	1
3	Yes	1
3a	Prefer standards	1
3b	Prefer standards	1
3c Data	Yes	1
3c Application	Yes	1
3c Process	Yes	1
3c GUI	No	0
3d	No	0
3e	Yes	1
4	Yes, for IT-infrastructure operations. Change, Incident and Problem to some degree.	1
4a	See above	1
4b	See above	1
5	No development, but distribution.	1
5a	No	0
5b	No	0
5c	SCCM and SAP transport system	1
6	Firewall	1
7	Reactive. There is understanding for reactive IT-operations.	1
8	Federal	1
	Operational level score	33

Table 16.8: IT Supplier operational level survey

Further questions and comments, CIO IT supplier:
Where the questions asked relevant?

- The questions asked where very relevant.

Is it OK to publish answers?

- Answer: Yes. However, want this survey to be depersonalized.

Working to improve business process standardization and business process integration.
Goal is Unification.

16.4 Interview with Knut-Olav Traa, Statkraft

Statkraft is a leading company in hydropower internationally and Europe largest generator of renewable energy. The Group produces hydropower, wind power, gas-fired power and district heating and is a global player in energy market operations. Statkraft has 3600 employees in more than 20 countries (?).

Knut-Olav Traa, Statkraft, Section manager Integration (MIDI): 30. October 2014
Email: Knut-Olav.Traa@statkraft.com

Question no.	Statkraft strategic level answers	Score
1	c	1
2	b	1
3	b	1
4	b	1
5	a and b	1
6	d	1
7	b and c	1
8a	High, to a large degree.	1
8b	High, can be improved.	1
9	Yes	1
9a	Yes	1
10	Yes	1
10a	Yes	1
11	Yes	1
12	Overall guidelines from the corporation. For MIDI, IT follow-up	1
	Strategic level score	15

Table 16.9: Statkraft strategic level survey

Question no.	Statkraft tactical level answers	Score
1	TOGAF in a source of inspiration for Enterprise Architecture. For infrastructure: ITIL	1
1a	ITIL to a large degree (Most important ITIL processes)	1
1b	For ITIL: Common terminology. For TOGAF: Common terminology for architecture, 4 levels.	1
2	Marketing/trading, power generation, international power generation, HR, economy and finance.	1
2a	Most core processes, some for power generation	1
3	Strategic, tactical and operational. Priority board/meeting: Representatives from HR, economy and finance at lower level. However, they have decision authority!	1
3a	Project portfolio board. Corporate and IT-level.	1
3b	Priority board/meeting	1
4	CEO own the processes. Manager for business unit is responsible.	1
5	The business side own the data	1
5a	No, problem identified. Goal not reached so far.	0
6	Business units Statkraft	
7	Priority board/meeting can be an arena. Process owner has delegated decision authority.	1
7a	-	0
7b Process	Business side	1
7b Application	Business side	1
7b Technology	IT	1
8	Yes	1
8a	Yes	1
8b	Priority board/meeting	1
9	See below	1
9a	Yes and no. Must be better	1
9b	Yes and no. Must be better.	1
10	Yes, for security, integration and the most important questions.	1
11	No. However it is defined.	0
12	Yes and yes	1
13	Yes for SOA. For governance, adapted standard framework.	1
13a	For SOA: Using external training suppliers. Plus programs (Training plan ie. sessions with HR and business side)	1
14	Dont know	0
15	No, pragmatic approach. Roadmap at system level.	1
16	Dont know	0
17	Using following practice: Risk manager, intgration security architect and emergency plan.	1
17a	Na	0

Question no.	Statkraft tactical level answers	Score
18	Yes	1
18a	To a large degree. More effective and faster response time.	1
19	Some, lack of model	1
19a	Na	0
19b	Na	0
20	We have several models. This should be improved and should perhaps be prioritized.	1
20a	Who is responsible for data. What data within the are is important for systems. Describe where master shall be.	1
21a	Yes, Integration principles approved. Enterprise architecture work started: Information architecture, Enterprise architecture and security.	1
21b	See above	1
21c	Yes	1
21d	Yes. Broken window principle.	1
22a	Yes	1
22b	Have a model	1
23a	Yes	1
23b	Priority board/meeting	1
23c	Priority board/meeting	1
23d	Yes, however not always.	1
24	Privacy act	1
	Operational level score	42

Table 16.11: Statkraft tactical level survey (continues)

Question no.	Statkraft operational level answers	Score
1	Yes	1
2	Yes, is being composed now.	1
3	Yes	1
3a	Yes, some	1
3b	Yes, what is the distinction between SOA and software?	1
3c Data	Yes	1
3c Application	Yes	1
3c Process	Yes	1
3c GUI	Yes	1
3d	Yes, there are some reasoned exceptions	1
3e	Separate unit. Dont know.	0
4	ITIL, Scrum and Canban.	1
4a	Yes	1
4b	Incident, change, problem and service request.	1
5	Yes	1
5a	Yes, Subversion	1
5b	Yes, Team City and N.Ant.	1
5c	Biztalk Deployment framework	1
6	Firefighting in Statkraft. To a less degree now than before.	1
7	Proactive to a large degree.	1
8	Business side decides. IT take responsibility.	1
	Operational level score	42

Table 16.12: Statkraft operational level survey (continues)

Further questions and comments, Knut Olav Traa:
Where the questions asked relevant?

- Most questions asked where relevant.
- However, some questions where beyond the integration area in Statkraft, such as model for organization changes. Thus those questions where difficult to answer.

Is it OK to publish answers?

- Answer: Yes

16.5 Interview with Morten Vaagen and Jarle Boland, Sykehuspartne

Sykehuspartner was established in 2003 as a separate unit in the Regional Health Authority in South-East Norway, in which includes the hospitals in the following counties: Vest-Agder, Aust-Agder, Telemark, Vestfold, Buskerud, stfold, Akershus, Oslo, Hedmark og Oppland. Total population is about 2850000.

Sykehuspartner has the superior responsibility for ICT, HR and purchase/procurement services for all the hospitals in the region. The mission is to deliver and operate such non-medical services (96).

Morten Vaagen, Section Manager Architecture and Jarle Boland, responsible for The Integration Factory. Skyen/Oslo, 30. October 2014 15.00-17.00.
Email: morten.vagen@sykehuspartner.no, jarle.boland@vali.no

Question no.	Sykehuspartner strategic level Answers	Score
1	a	1
2	a	1
3	a	1
4	b	1
5	b	1
6	d	1
7	b	1
8a	High	1
8b	High	1
9	Yes	1
9a	Yes	1
10	Yes	1
10a	Yes	1
11	Not easy to answer	0
12	Visions, goals, national guidelines.	1
	Strategic level score	14

Table 16.13: Sykehuspartner strategic level survey

Question no.	Sykehuspartner tactical level Answers	Score
1	ITIL, TOGAF and Gartner SOA Center of Excellence	1
1a	ITIL and TOGAF is well implemented.	1
1b	A way of structuring how the enterprise operate. Clear change and incident process.	1
2	ICT-Services, Project Services, HR, Purchase and Logistics.	1
2a	ICT-Services, Purchase and Logistics.	1
3	Y-model. See figure and definitions below.	1
3a	Project portfolio management	1
3b	Own operational management organization.	1
4	The director, the line organization own the processes.	1
5	The Health Authority own the data.	1
5a	Yes, is defined by Norwegian legislation.	1
6	The patient, RHF and Ministry of Health and Care Services	1
7	Strategies and long term planning. Process owners RHF and data owner HF.	1
7a	Regional organizing is clear and well defined. RHF has taken control.	1
7b Process	Coordinated from RHF.	1
7b Application	SP	1
7b Technology	SP	1
8	Yes	1
8a	Yes	1
8b	Yes	1
9	Yes	1
9a	Yes, absolutely	1
9b	Yes, absolutely	1
10	Yes	1
11	Yes, we do have some KPIs for that purpose.	1
12	Yes, mostly operational management team. Also for projects.	1
13	Yes, loud and clear.	1
13a	Courses, formal process for hand-over, documentation, solutions, guidelines and routines.	1
14	Yes, for the integration area, not for business area.	1
15	Yes, a clear cloud based virtualization strategy.	1
16	Yes, for integrations is a plan defined. 24. November there is Kick-off for Center of Excellence.	1

Table 16.14: Sykehuspartner tactical level survey

Question no.	Sykehuspartner tactical level Answers	Score
17	ISO 27001 and Own unit for security	1
17a	Yes. At some areas there are exceptions.	1
18	Yes	1
18a	Yes, to a very large degree!	1
19	Yes	1
19a	Yes, for the health care sector this is clearly defined.	1
19b	Yes. Eg. a patient is clearly defined.	1
20	Yes, for different business areas.	1
20a	See above	1
21a	Yes, DIFI	1
21b	Yes	1
21c	See above	1
21d	Yes	1
22a	Yes, but complex. General IT-service hierarchy.	1
22b	Mostly no, some for SMS messages.	0,5
23a	Yes, to a large degree.	1
23b	Solved by operational management organization.	1
23c	There is a line function/unit in SP working with processes.	1
23d	Yes, try to get away from personal dependencies.	1
24	Privacy act, Patient legislation and Patient care legislation.	1
	Tactical level score	50,5

Table 16.15: Sykehuspartner tactical level survey (continues)

Question no.	Sykehuspartner operational level Answers	Score
1	Yes	1
2	Yes, level classification and context model	1
3	Yes	1
3a	Yes	1
3b	Yes	1
3c Data	Yes	1
3c Application	Yes	1
3c Process	Yes	1
3d GUI	Yes	1
3d	Yes, moving away from (tidy-up)	1
3e	Na	0
4	Incident, Change, Problem, Service request (varying degrees). Started to look at life cycle management.	1
4a	Yes	1
4b	Yes	1
5	Yes	1
5a	TFS, Microsoft Team Foundation	1
5b	TFS	1
5c	TFS	1
6	Daily routines and follow-up.	1
7	Mostly proactive. Some old legacy.. Regional monitoring.	1
8	Moved to RHF-level. Core processes. Goes in direction of more centralization.	1
Operational level score		20

Table 16.16: Sykehuspartner operational level survey

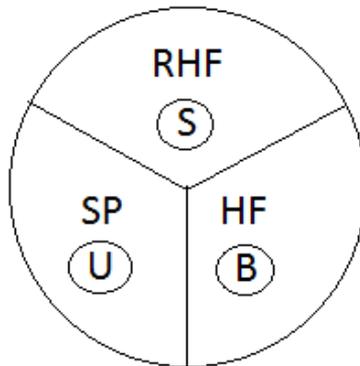


Figure 16.1: Y-model

RHF = "Regionalt HelseForetak" = Regional Health Authority

HF = "HelseForetak" = Health Authority

SP = "Sykehuspartner" = Hospital Partner

U = "Utforende" = Executing

S = "Styrende" = Steering

B = "Bestiller" = Orderer

Questions and comments, Sykehuspartner (mail from 22. december 2014):

Where the questions relevant?

Is it OK to publish answers?

- Yes, the questions where relevant.
 - We needed some time to accurately understand what you where looking for. Sometimes we needed some time to imagine whether the context was Sykehuspartner or the Regional Health Authority.
- Yes, it is OK to publish the answers.

16.6 Interview with Frode Junge and Bard Grodem, Hemit

Hemit is The Central Norway Regional Health Authority total supplier of it-systems, from infrastructure to applications and equipment. The customers are the Health Authorities in Central Norway.

Frode Junge, team manager integration development/IT-operations and Brd Grdem team manager architecture. Lync meeting, 15. December 2014.

Email: Frode.Junge@hemit.no and Bard.Grodem@hemit.no

Question no.	Hemit strategic level answers	Score
1	a and b. Health Authority (HF) is in this survey defined as a customer. Suppliers are global.	1
2	b and c. Commin Patient Journal system. The Core Journal System at bot national and local level	1
3	b	1
4	b and c	1
5	a. Each Health Authority (HF) decide design over business processes.	1
6	b. However, data owned by Health Authority (HF). + Some local owned data.	1
7	b. Health Authority (HF) request solutions from Hemit.	1
8a	Low. Work on standardization on patient processes has started.	1
8b	To a varying degree. Patient Journal data and medical data are available i a Regional Patient Journal system. However, data access is restricted by legislation. Patient data access must be approved by the local Health Authority (HF).	1
9	Yes	1
9a	Yes	1
10	Yes	1
10a	Yes	1
11	Yes	1
12	Technology, innovation, legislation, lot at least requirements from the customers. Guidelines from the parliament, government and Ministry of Health.	1
	Strategic level score	15

Table 16.17: Hemit strategic level survey

Question no.	Hemit tactical level answers	Score
1	ITIL and TOGAF	1
1a	ITIL to a high degree. Is in front with ITIL. TOGAF to a bit less degree. It gives guidelines for the architectural work.	1
1b	Good experience with ITIL. Control over IT-operations. And good experience with TOGAF.	1
2	Give health care to the population.	1
2a	yes	1
3	Process is defined.	1
3a	Yes	1
3b	Yes	1
4	Yes, RHF (Regional Health Authority)	1
5	Juridical ownership of the data is at Health Authority (HF) level. Health Authority (HF) is an autonomous enterprise.	1
5a	Yes	1
6	The population, parliament and Ministry of Health.	1
7	Close integration	1
7a	At director level at the Health Authority (HF). Own the integrations and the data. Delegated to clinic management and head of department.	1
7b Process	Same as above	1
7b Application	Hemit	1
7b Technology	Hemit	1
8	-	0
8a	Yes	1
8b	Yes. Well defined assignment process. Management via ITIL processes.	1
9	To a small degree.	0,5
9a	To a small degree.	0,5
9b	To a small degree.	0,5
10	To a small degree.	0,5
11	Yes	1
12	Yes and yes for IT-operations.	1
13	Yes	1
13a	Competence plans, competence transfer	1
14	Yes, to some degree.	0,5
15	Yes	1
16	No	0
17	Risk analysis. Ruled by legislation. A security board approve solutions. And regional security forum.	1
17a	Yes, as good as possible.	1

Table 16.18: Hemit tactical level survey

Question no.	Hemit tactical level answers	Score
18	Yes	1
18a	It is possible to introduce new products, better integrated, into existing portfolio.	1
19	A bit thin. Should talk to someone else. No clear information model.	0
19a	-	0
19b	Well defined for the patient. Rest of it is lacking.	1
20	Under construction. Master data is established, but not for everyting.	0,5
20a	What data is fetched where. What system own the patient.	1
21a	Yes, DIFI	1
21b	Yes	1
21c	Yes	1
21d	-	0
22a	Yes	1
22b	No. However, there are pricing against external enterprises as primary health care.	0
23a	Yes, government regulations	1
23b	Not easy to answer.	0
23c	Process owner.	1
23d	Yes	1
24	Health legislation, Journal legislation and other legislation.	1
	Tactical level score	41

Table 16.19: Hemit tactical level survey (continues)

Question no.	Hemit operational level answers	Score
1	Yes	1
2	Yes	1
3	Yes	1
3a	Yes	1
3b	Yes	1
3c Data	Yes	1
3c Application	Yes	1
3c Process	Yes	1
3c GUI	Yes	1
3d	Yes	1
3e	Yes, horizontal.	1
4	Change, Problem, incident and Release processes.	1
4a	-	0
4b	-	0
5	Yes	1
5a	Yes	1
5b	Yes, tool for building.	1
5c	Yes	1
6	Change process.	1
7	Starting to be capable. Mainly proactive.	1
8	The Health Authority (HF)	1
	Operational level score	19

Table 16.20: Hemit Operational level survey

Further question and comments, Frode Junge and Bard Grodem:

- Question: Where the questions asked relevant?
Answer: Yes, most of them. Some where a bit on the edge.
- Question: Are there any questions missing?
Answer: Can remember any.
- Other comments: Thorough questionnaire.
- RHF = "Regionalt HelseForetak" = Regional Health Authority
- HF = "HelseForetak" = Health Authority

Is it OK to publish answers?

- Answer: Yes

16.7 Interview with Senior Consultant, IT-operations for bank

Enterprise in which this interview concern is anonymized as requested by the senior consultant interviewed.

Name is depersonalized, IT-operations for bank, Senior Consultant, 13. November 2014

Email: an-email@org.com

Question no.	Bank strategic level answers	Score
1	a	1
2	c	1
3	d	1
4	b	1
5	d. Some come with initiatives, however architects decide how things are connected.	1
6	b	1
7	b and d	1
8a	-	0
8b	-	0
9	Yes	1
9a	Yes	1
10	Yes	1
10a	Yes	1
11	Hard to tell	0
12	Hard to tell	0
	Strategic level score	11

Table 16.21: Bank Strategic level survey

Question no.	Bank tactical level answers	Score
1	ITIL and TOGAF	1
1a	ITIL used to large degree in change management. For TOGAF more uncertain. Many architects have TOGAF training, but do not necessarily run by the principles. Adaptive approach.	1
1b	The ITIL practice continues. They are now being more clever to follow the process. For TOGAF it gives a foundation and consciousness for architecture.	1
2	Transaction of payments, Financing, Savings, Insurance and Pension.	1
2a	All	1
3	-	0
3a	Course in Prince2	1
3b	Yes, ITIL based	1
4	The customers (banks) own the processes	1
5	The customers	1
5a	Yes, however this is a challenge. Some suppliers attempt to drag the data to their systems.	1
6	Customers of the banks and end users.	1
7	-	0
7a	Project group and personal initiative	1
7b Process	System owner	1
7b Application	System responsible is defined	1
7b Technology	System responsible is defined	1
8	-	0
8a	Training in Prince2 project method.	1
8b	System portfolio	1
9	-	0
9a	Yes, can make improved estimates.	1
9b	Have run some cycles. Not a permanent practice.	0,5
10	Yes, for road map. For, gap analysis, dont know. Do have a target architecture. It might not be well communicated.	1
11	Some guidelines. And they have some roles connected to governance.	0,5
12	Yes, development teams. The system responsible have some roles attached to governance.	1
13	There are some guidelines.	0,5
13a	For development and IT operations management there are some check points. RUP based system development process.	0,5
14	Yes, RUP based.	1
15	Yes, RUP based.	1

Table 16.22: Bank tactical level survey

Question no.	Bank tactical level answers	Score
16	Na	0
17	Risk evaluation	1
17a	Risk evaluation applied. There are no production deployments if high risk!	1
18	Uncertain	0
18a	The integration platform is perceived as cumbersome. However, the situation has not become worse.	0,5
19	In preparation. Some work done on basis data. Impossible to define only one information model.	0,5
19a	Basis customer data.	1
19b	No, not documented. And there is not only one place to look up.	0
20	The basis data part.	1
20a	Customer data and where master data for customer is. The customer data is now owned by the bank.	1
21a	The RUP-process gives guidelines. Non functional requirements for architects. Focus on projects.	1
21b	Yes	1
21c	Yes	1
21d	Yes, policy. The IT Operations management organization is very conscious about this. However, this depends on the system responsible. There might be different policies from system to system.	1
22a	Internal invoicing	1
22b	Yes, for a bank 95 percent of the transactions come from the internet bank portal. In a bank a everything is charged. Costs sharing model Fixed price, used price (how often), subscribing price and transaction price. For for services there is a fine grained cost distribution model rewarding re-use.	1
23a	Yes, contracts and compulsory competitive tendering.	1
23b	Most changes are project based and anchored by the system owner and system responsible.	1
23c	Functional architects, system responsible.	1
23d	Yes, but there is there is a start cost for changing consultants.	1
24	Personal act, legislation related to finance and legislation related to safekeeping of credit card information.	1
	Tactical level score	41

Table 16.23: Bank tactical level survey (continues)

Question no.	Bank operational level answers	Score
1	Yes	1
2	Yes	1
3	Yes	1
3a	Yes, there are guidelines	1
3b	Yes, there are guidelines	1
3c Data	Yes	1
3c Application	Yes	1
3c Process	Yes, a few	0,5
3d GUI	Yes	1
3d	Yes	1
3e	Yes	1
4	Yes, the entire spectre for IT-operations	1
4a	-	0
4b	-	0
5	Yes	1
5a	Yes	1
5b	Yes	1
5c	Yes, but different tool.	1
6	There are differences between environments.	1
7	Pro-active. IT-Operations planning at a high level.	1
8	System responsible.	1
	Tactical level score	11

Table 16.24: Bank tactical level survey (continues)

Further questions and comments, Senior Consultant, IT-operations for bank:

1. Question? The questions asked. Are they relevant?
Answer: Yes, relevant questions, as a consultant I do not have overview over strategic issues. However it gives a good picture over practice for integrations. At strategic level questions where a bit over my head.
2. General comment:
Enterprises are not sure why they implement SOA. They want SOA so they can integrate against cumbersome specialized systems.
3. Criticism: Focus on integration in stead of SOA.

Is it OK to publish answers?

- Answer: Yes. Want this survey to be depersonalized.

16.8 Interview with Harald Wesenberg, Statoil

Statoil ASA, is a Norwegian multinational oil and gas company headquartered in Stavanger, Norway. It is a fully integrated petroleum company with operations in thirty-six countries. By revenue, Statoil is ranked by Forbes Magazine (2013) as the world's eleventh largest oil and gas company and the twenty-sixth largest company, regardless of industry, by profit in the world. The company has about 23,000 employees /citeStatoil2.

Harald Wesenberg, Statoil, Leading Advisor Solution Architecture, 14 November 2014

Email: hwes@statoil.com

Question no.	Statoil strategic level answers	Score
1	a	1
2	b and d	1
3	b	1
4	b and d	1
5	b	1
6	d	1
7	b	1
8a	High	1
8b	High	1
9	Yes	1
9a	Yes	1
10	Yes	1
10a	Yes	1
11	Yes, because of production targets and other targets	1
12	The Statoil Strategy, technology, exploration, project portfolio, external trends as: Big Data, Open Link Data and Consumerisation. This drives IT-strategy, technology and exploration strategy, again supported by IT-strategy that again supports business strategy.	1
	Strategic level score	15

Table 16.25: Statoil strategic level survey

Question no.	Statoil tactical level answers	Score
1	TOGAF has been applied as framework for enterprise architecture work at general basis. COBIT has been applied as basis for enterprise architecture for the IT-process. COBIT is really just content within TOGAF. COBIT is a framework for how to run an IT-organization. One can fill the TOGAF framework with IT-related content. TOGAF was applied to a relative large extent. COBIT was applied for IT until 2 years ago. But it is gone now.	1
1a	Now, we do not have much IT-Governance. Have a Shared Service organization, so we use ITIL. ITIL is applied as Shared Service steering tool for tactical IT, thus IT-deliveries. Practical IT-deliveries take place with ITIL background. There are other process variants of TOGAF as well. Removal of COBIT was reasoned by a initiative called: Simplification of governance processes Forenkling av styring av prosesser. The number of governance elements should be cut by 20 percent. And there is something about personal interest and personal drive in the people positioning these governance functions. Had some people that where very keen on TOGAF and the work done there. Then those went over to other roles. Thereby the momentum around the TOGAF processes disappeared a bit. The TOGAF process was personal dependent.	1
1b	Statoil have variants of TOGAF. Management Architecture is applied. What is done through the Management Architecture process is that the activities in TOGAF are distributed over the existing governance structure. The execution of of TOGAF have been adapted existing roles and existing mandates in the organization. This instead of introducing a TOGAF organization living on the outside of the existing organization. TOGAF is adapted to Statoil.	1
2	Exploration, petroleum technology, well drilling, project development, operations and maintenance, marketing and supply.	1
2a	All	1
3	The IT-Arena process.	1
3a	Same as above.	1
3b	Same as above. Does not distinguish between projects and IT-operations. We are nearly back to the late 90s where everything was one team. Product lifecycle teams are introduced. In which is a DevOps variant. Product area boards and product owners are responsible for the various products. Changes are proposed through Scrum product backlog items. Product and product owners receive their budget from IT-Arena and can make their own priorities.	1
4	The process owners in the line organization.	1
5	The line organization.	1

Table 16.26: Statoil tactical level survey

Question no.	Statoil tactical level answers	Score
5a	Yes, one cannot create data i Statoil without first defining ownership. All data in Statoil have default owner. However, this is no quality control.	1
6	Process owners and corporate directors.	1
7	Yes, steering coordinators which are the process owners longer arm in the line organization.	1
7a	Steering coordinator	1
7b Process	Decisions made by process owners. The steering coordinator introduce the process in the line organization.	1
7b Application	Application changes are done by the product owners. For deployment of changes in the applications in the large business areas the steering coordinator plays a role. This often implies changes in work form and work routines. Therefore the steering coordinator must be involved. And then there is the steering coordinator network.	1
7b Technology	IT-Arena	1
8	Yes, We have the Product Area Board. Within a domain as e.g. exploration the Product Area Board is responsible for the portfolio management within its product area such as eco systems and products belonging together.	1
8a	Yes, Product Area Board.	1
8b	Yes, Product Area Board. This is really a DevOps implementation organization. It is up-scaled to function in a large organization. It is called: Product Owner, Product Area Board and Product Life Cycle Team, but it is really an implementation of DevOps. It was introduced 1. April this year, so it's new. Before it was chaos and coordination..	1
9	Yes, Product Life Cycle Team (PLC-team)	1
9a	PLC-team (Called DevOps in the rest of the world)	1
9b	Yes, this is PLC-team responsibility. They shall have a road-map to handle it.	1
10	Yes, for product and product area	1
11	Yes, we are now moving from a project and IT-operations model to a DevOps model. We have a target governance model for DevOps. However, we are not there, yet.	1
12	Yes	1
13	Yes, each for PLC-team. Shall hold an overview over how training is carried out.	1
13a	Each PLC team shall hold an overview over how training is carried out.	1
14	Yes all the time. There is an own process describing process transitions.	1
15	Yes	1
16	The organization is in continuous change. However, there is hardly a superior plan.	1

Table 16.27: Statoil tactical level survey (continues)

Question no.	Statoil tactical level answers	Score
17	Several risk management hand books and main handbook.	1
17a	Yes, High focus on compliance and leadership.	1
18	Service orientation has lead to increased agility. It has lead to improved re-use of services than before. Whether Enterprise architecture (EA) and governance have contributed to increased agility, the answer is no. EA does not in it self lead to improved agility. EA and Governance is implemented for control and cost-reduction.	1
18a	Se above.	1
19	Yes	1
19a	The most dominant information objects objects in Statoil, its ownership and where the master data is placed.	1
19b	Yes	1
20	Yes	1
20a	Did not find the description.	0
21a	Yes, described in the Statoil Management System.	1
21b	Yes, same as above.	1
21c	Yes, same as above.	1
21d	Yes, same as above.	1
22a	Yes, there is a price model for everything.	1
22b	No, however the prices are followed-up by the procurement/purchase department.	0,5
23a	Yes, the procurement/purchase organization.	1
23b	Product Area Board and process owners.	1
23c	The line in the business unit.	1
23d	Yes	1
24	The local legislation as Statoil operates in more than 40 countries.	1
	Tactical level score	49,5

Table 16.28: Statoil tactical level survey (continues)

Question no.	Statoil operational level answers	Score
1	PLC-team and platform team. A PLC-team is responsible for a product. Eg. Reporting and Trading System (RATS). While a platform team is responsible for delivering platform services as database. Platform as Service.	1
2	Yes, is described in a Information Management document as well as Information Security. It says something about how classification of information i different classification levels shall be handled.	1
3	Yes, guidelines described in governance document. Detailed integration principles are defined in each PLC-team and Product Area Board for the Ecosystems. This because principle details for integrations are Ecosystem dependent. Having guidelines described in governance document and detailed integration principles defined at a lower level make it possible to avoid conflicts concerning architecture perceptions. Breach of guidelines must be reasoned.	1
3a	Requirements and guidelines are implemented in each PLC-team.	1
3b	Requirements and guidelines are implemented in each PLC-team.	1
3c Data	Yes, ETL integrates operative, tactical and strategic systems such as RATS and for data warehouse purposes. Do prefer REST at integration method. Do not prefer orchestration solutions such as Oracle Fusion Middelware and database links.	1
3c Application	Yes, REST, Biztalk and MQ	1
3c Process	Yes, many Ecosystems are delivered with a work flow engine such as SAP. That kind of tool has an important function in an ecosystem. If a transection starts in an ecosystem and is handed over to an another ecosystem. There probably will be a technology change between ecosystems. And there probably will be a transaction hand shake handover to the next ecosystem. The transaction probably will live in several ecosystems. Eg. a transaction is handed over from RATS to SAP. There are clear borders for business processes and IT-systems. The IT-system shall not pass the border for the business process. An important principle is to information borders and process borders shall follow each other. This is described in Statoil Governance document Appendix B? (27).	1
3d GUI	Yes, there are many portals, but no uber-portal.	1
3d	Yes, try to get away from that.	1
3e	Yes	1
4	Yes, most processes	1
4a	-	0
4b	-	0

Table 16.29: Statoil operational level survey

Question no.	Statoil operational level answers	Score
5	Yes, however not all teams are equally clever.	1
5a	Yes	1
5b	Yes, Git and Jenkins	1
5c	Don't know. CMDB has tools.	0
6	Coordination	1
7	Very reactive. This caused by the Service Management process in ITIL. Must monitor every incident.	1
8	Product Owner and the Product Area Board.	1
	Operational level score	18

Table 16.30: Statoil operational level survey (continues)

Further questions and comments, Harald Wesenberg:

1. The questions asked where they relevant?
Answer: Yes, the question where very relevant?
2. Any missing questions?
Answer: No, I don't think so.
3. Is it ok to publish answers?
Answer: Yes
4. Advice from Harald:
Use more time on content as comparing practice for enterprises such as Statkraft and Statoil. And choose an integration strategy. Enterprises operate under different conditions such as local or global businesses.

Definition of the Statoil IT-Arena (38, p. 38):

The information technology arena ensures that the portfolio of major IT initiatives support the companys strategy and creates ownership across the group. The arena must consider the consequences and risks of the company by providing their comments to the IT portfolio and the financial targets set.

Appendix C

NTNU internal surveys NTNU Actual Practice Survey interviewing:

1. NTNU Organization director, Ida Munkeby
2. NTNU IT-Director, Hakon Alstad
3. NTNU IT Section Manager, Stein Stendahl
4. NTNU IT-Architect/Senior Lecturer, Carl-Fredrik Soerensen
5. NTNU IT-Architect, Ole Ingvard Langfeldt

Interviews conducted for strategic, tactical and operational level. The NTNU Actual Practice Survey is based on Questionnaire (Appendix A)

16.9 Interview with Ida Munkeby, NTNU Director of Organization

The Director of Organization has responsibility for personnel, communication, health, safety and environment and ICT. These are all organized in their own divisions.

Ida Munkeby, NTNU, Director of Organization, 4. December 2014

Email: ida.munkeby@ntnu.no

Question no.	NTNU Director of Organization strategic level answers	Score
1	Cant answer. The picture is complex.	0
2	a. However, at NTNU all categories of transactions are representative.	1
3	a, b and c. At NTNU, we are moving from autonomy. Historically, the faculties have had a large degree of autonomy. This is not desirable because of efficiency. There is a great desire for standardizing processes both vertically and horizontally. All categories are represented.	1
4	a and b. Everyone are placed under NTNUs strategy. All managers have a degree of autonomy. This because they have delegated authority and responsibility.	1
5	a. and b. NTNU must relate to legislation as: Act relating to Universities and University colleges, The Working Environment Act and Act relating to Civil Servants. In addition, NTNU must relate to its budgets. Within these frames, there is a room for maneuver. Our managers must have the room to rig things best possible to obtain efficiency. A main concern is getting away from silos and silo thinking.	1
6	c. At NTNU, we are moving against a.	1
7	a. and b. At NTNU, we are moving against b. NTNU attempt to be more coordinated regarding purchase. IT-Division is central as an adviser.	1
8a	It is hard to answer. There is a large degree variation regarding standardization of processes at NTNU.	1
8b	It is hard to answer. Have a potential for improvement.	1
9	Yes	1
9a	Yes	1

Table 16.31: NTNU Director of Organization strategic level survey

Question no.	NTNU Director of Organization strategic level answers	Score
10	No, is about to formulate an IT-policy for NTNU.	0,5
10a	No, not yet. There shall be only one strategy for NTNU. And that is the superior/general strategy. Below there are policies and action plans.	1
11	Yes and No. This because where we want to and the level of ambition at NTNU is not yet defined. Still this work has started. Eg. Program for Innovative Education. The red line is connected.	1
12	Various orders from Rector, strategic decisions from the NTNU management, strategic decisions from The Board of NTNU and decision from the owner. The Ministry of Education and Research.	1
	Strategic level score	13,5

Table 16.32: NTNU Director of Organization strategic level survey (continues)

Question no.	NTNU Director of Organization tactical level answers	Score
1	I do not have relationship with those frameworks. However, I am familiar with the philosophy.	0
1a	Na	0
1b	Na	0
2	Research, Education, Innovation and Communication	1
2a	Research, Education and Communication	1
3	The policy is decided by the Rector. The Directors of IT, Organization and Finance is involved in the project: IT-board. First the IT-board is meant for the Central Administration at NTNU. Then there is the IT-operations committee with local and central decision makers.	1
3a	The Project Office at the IT-Division and the IT-Board	1
3b	The IT-manager (CIO)	1
4	Rector. Rector has authorized functions. Prorector for Education owns processes for education and so on. Delegation of authority.	1
5	The Norwegian State and NTNU as organization.	1
5a	Cant answer.	0
6	The Ministry of Education and Research, The Government, Industry and commerce, students and the society.	1
7	It is measured in many ways. It is decisive that goal are achieved. E.g. Statistics for candidate production and publication points.	1
7a	-	0
7b Process	Ownership is on underlying level. Requires insight in processes.	1
7b Application	-	0
7b Technology	-	0
8	-	0
8a	The new IT-programmes	1
8b	Improving	1
9	-	0
9a	Want to have an overview	1
9b	NTNU can benefit on better system effectiveness. However, I am comfortable with current work.	1
10	Cant answer. I experience a reflection around the requirements to make system effectiveness.	0
11	Yes, through reorganization of Management and Leadership. This is on track.	1
12	Yes, the governance team is in the IT-Division. Arne Fjerdrumsmoen and Hkon Alstad with more people.	1
13	No, Dont think so.	0

Table 16.33: NTNU Director of Organization tactical level survey (continues)

Question no.	NTNU Director of Organization tactical level answers	Score
13a	-	0
14	Cant answer. There is a plan for re-adjustment. Referring to NOKUT.	0
15	Cant answer.	0
16	No, NTNU does not have a superior plan. NTNU have a strategy and an established policy.	1
17	NTNU do have an Emergency Plan, supported by a Risk analysis, IT-security and Information security documents.	1
17a	Yes, NTNU run several drills. IT-security is vulnerable.	1
18	Question not asked (irrelevant)	0
18a	Question not asked (irrelevant)	0
19	Cant answer.	0
19a	Question not asked (irrelevant)	0
19b	Question not asked (irrelevant)	0
20	Question not asked (irrelevant)	0
20a	Question not asked (irrelevant)	0
21a	No	0
21b	Cant answer.	0
21c	No	0
21d	Question not asked (irrelevant)	0
22a	Dont know	0
22b	Question not asked (irrelevant)	0
23a	Yes	1
23b	In many connections and contexts.	1
23c	The entire organization, responsibility at leaders.	1
23d	Na	0
24	The Civil servant act	1
	Tactical level score	23

Table 16.34: NTNU Director of Organization tactical level survey (continues)

Nb! The questions at operational level where not asked as they are irrelevant for the NTNU director of Organization.

Further questions and comments:

The questions asked where they relevant?

- The questions where relevant.
- The questions made me think.

Is it ok to publish the answers?

- Answer: Yes

16.10 Interview with Hakon Alstad, NTNU IT-Director

The NTNU IT-Division is organized in the central administration under the NTNU Organization Director. And counts about 100 employees. The main responsibilities for NTNU IT-Division are (5):

- IT operations for common and basis services for NTNU.
- Develop web based solutions for NTNU.
- Advisory activities for the NTNU organization in IT.

Hakon Alstad, NTNU IT-Division, IT Director, 19, November 2014 ..

Email: hakon.alstad@ntnu.no

Question no.	NTNU IT-Director strategic level answers	Score
1	c	1
2	a	1
3	a	1
4	b	1
5	a	1
6	a and d	1
7	a and b (Both local and central IT)	1
8a	Low	1
8b	High	1
9	Yes	1
9a	Yes	1
10	Yes	1
10a	Yes	1
11	Yes	1
12	Establishment of programs and project portfolio. At central level the programs are the strategic development of IT.	1
	Strategic level score	15

Table 16.35: NTNU IT-Director strategic level survey

Question no.	NTNU IT-Director tactical level answers	Score
1	ITIL	1
1a	To a large degree. In particular Change and Incident.	1
1b	Good	1
2	Education, research and innovation.	1
2a	Education mostly, partly for research as we support integration against the research report system Cristin and DBH (Database for Higher Education).	1
3	We have a model. This is really a very lite governance model derived from Gartner. Does not yet have a complete scope. It is the project portfolio in the central administration.	1
3a	Same as above for programs "IT-Board"	1
3b	Partly, and it is very lite. Handled in the Operations Committee.	1
4	The line organization	1
5	The line organization	1
5a	No	0
6	Several, students, employees and the general public.	1
7	Intergrate mostly through projects and some through IT-operations.	1
7a	-	0
7b Process	The staff units themselves. Eg. if HR changes a process it is driven by HR.	1
7b Application	It is the IT-Division together with the system owners.	1
7b Technology	It is we, the IT-Division, and the purchasing/procurement department. And regulations for public procurement.	1
8	Yes	1
8a	Yes, its really good!	1
8b	Have barely started. Have made an Excel sheet over services linked up against enterprise targets.	0,5
9	-	0
9a	The purchase and procurement regulations force us to life cycle management. However, it is not good enough.	0,5
9b	No, not today.	0
10	Partly. Have made a target for Data Flow and some other areas.	0,5
11	No	0
12	Yes, for development. (Yes and no). The operations committee does some governance tasks.	1
13	Based on experience and knowledge acquired in projects.	1
13a	See above.	1
14	Both yes and no. Projects are transitions of services. Eg. IAM.	0,5
15	Do not have that kind of plan. However, there is work going on for transition of data networks. Much work is organized in projects.	0
16	No, but there is a process started, that may end up with a plan.	0
17	ISO 27001. And are about to adopt the ITIL security process. Planned to be introduced.	1

Question no.	NTNU IT-Director tactical level answers	Score
17a	Yes? (Check interview tape/paper)	1
18	Yes, Eg. for the Parking App. It was a very fast implementation done by the TIA team and technology. (TIA= Service Oriented Integration Technology)	1
18a	With the experience so far, to a large degree.	1
19	Yes, it is in the Cognos system (Business intelligence system) for enterprise management.	1
19a	See above	1
19b	Definitively in Cognos. Contact Torgeir Sesseng for further information.	1
20	Dont know, refer to Cognos.	0
20a	-	0
21a	Yes, the ICT target picture document. Referring to Noralf Husby, acting ICT-architect at NTNU IT-Division.	1
21b	Yes	1
21c	Yes, same document, the ICT target picture document.	1
21d	No	0
22a	Yes	1
22b	Do have pricing for a few web-services. All customer services are calculated.	1
23a	Yes	1
23b	Cooperation between the IT-Division and system owners.	1
23c	The IT-Division.	1
23d	Yes	1
24	DIFIs guidelines and main principles. And the Local Government and Administration is now handing out directive for digitalization.	1
	Strategic level score	39

Table 16.37: NTNU IT-Director tactical level survey

Question no.	NTNU IT-Director operational level answers	Score
1	Yes	
2	Yes	
3	Na	
3a	Na	
3b	Na	
3c Data	Na	
3c Application	Na	
3c Process	Na	
3c GUI	Na	
3d	Na	
3e	Na	
4	Yes, there is six ITIL processes implemented or implementation is started: Service Level Management (SLM), Change, Incident, Config, Problem and Security. The three first processes are implemented to a very large degree.	
4a	Yes	
4b	Yes	
5	Na	
5a	Na	
5b	Na	
5c	Na	
6	Na	
7	With the Change process the IT-operations have become much more proactive.	
8	This responsibility is in two parts. The IT-Division for IT-basis services. And the professional departments for applications. Eg. the Finance Division.	
Strategic level score		39

Table 16.38: NTNU IT-Director tactical level survey

Further questions and comments:

Where the questions asked relevant?

- Answer: Good questions.
- Some questions at the start where a bit heavy.

Is it OK to publish answers?

- Answer: Yes

16.11 Interview with Stein Stendahl, Section Manager NTNU IT

The NTNU IT Application Section has following responsibilities: Development and operations of databases, integration solutions and web solutions (5).

Stein Stendahl, NTNU IT-Division, Section manager Application, 11. November 2014.

Email: stein.stendahl@ntnu.no

Question no.	NTNU IT Section Manager strategic level answers	Score
2	a	1
3	a, b and c	1
4	a	1
5	a, b (Employment and invoicing process) and c	1
6	Dont know	0
7	b (For basis IT-systems) and c (Local for others)	1
8a	Low compared with a german plant. High for student recruitment and student processes.	1
8b	High	1
9	Yes	1
9a	Yes	1
10	Yes	1
10a	Yes	1
11	No	0
12	For the IT-Division, the business demand. The project portfolio list. Legislation and rules, input from employees and trends in the IT-business.	1
Strategic level score		13

Table 16.39: NTNU IT Section Manager strategic level survey

Question no.	NTNU IT Section Manager tactical level answers	Score
1	ITIL, PAM, FHTD (From request to IT-operations) and SCRUM	1
1a	To a high degree	1
1b	Positive, however the frameworks must be adapted to requirements and environment.	1
2	Study process and research	1
2a	The study process	1
3	New model, The IT-board	1
3a	The IT-board	1
3b	Changes are implemented through RSO funds (Ramme, strategi, omstilling)= (Frame, strategy and adjustment)	1
4	Study process: The Student and Academic Division. Local units own local processes.	1
5	Unclearified	0
5a	No	0
6	All	1
7	No interaction or none..	0
7a	-	0
7b Process	In practice, the IT-Division	1
7b Application	Several Business Application owners	1
7b Technology	The IT-Division	1
8	Yes	1
8a	Yes, for projects very good. Not regarding portfolio and services.	1
8b	For some systems, based on individual effort. Noe service portfolio. (Check)	0,5
9	No	1
9a	No	1
9b	No	1
10	We have tried. Eg. For Kjerem to TIA. And the Innsida team have a clear vision about where they are and where they are going.	0,5
11	No	0
12	Yes, dev. team	1
13	No, not yet	0
13a	-	0
14	Yes for TIA, not at NTNU level	1
15	Yes for TIA, not at NTNU level	1
16	No	0
17	Is in the start phase	1
17a	-	0

Table 16.40: NTNU IT Section Manager tactical level survey

Question no.	NTNU IT Section Manager tactical level answers	Score
18	Dont know yet we hope	1
18a	-	0
19	We have many. We have to many. No standard	1
19a	-	0
19b	No	0
20	Dont know	0
20a	-	0
21a	Yes, DIFI	1
21b	Yes, for purchase, some for development, universal design WCAG.	1
21c	Yes	1
21d	No	0
22a	Yes	1
22b	We make new SLAs every time.	1
23a	Yes	1
23b	Not for processes	0
23c	For IT-division it is sent to the Orakel Support Services.	1
23d	Dont know	0
24	Privacy act, DIFIs principles and universal design.	1
	Tactical level score	33

Table 16.41: NTNU IT Section Manager tactical level survey (continues)

Question no.	NTNU IT Section Manager operational level answers	Score
1	Yes	1
2	Yes	1
3	No	0
3a	No	0
3b	No	0
3c Data	Yes	1
3c Application	Yes	1
3c Process	Yes, some for service desk	1
3c GUI	Yes, Innsida	1
3d	Yes	1
3e	Yes, move strait up.	1
4	Yes, Change, Incident, some Problem and some Config process (Config failed) and FHTD (IT order process).	1
4a	Yes	1
4b	Yes	1
5	Yes	1
5a	Yes	1
5b	Yes	1
5c	Yes	1
6	It depends on operational tasks. Now it is integrations.	1
7	Both 50/50	1
8	For some we have and for some we do not. Yes for large IT-Services we have business owners that are clear. However, for many small services as LDAP we do not have a distinct owner. There are not many that takes responsibility for data-integration and data.	0,5
Operational level score		17,5

Table 16.42: NTNU IT Section Manager operational level survey

Further questions and comments:

Where the questions asked relevant?

- Answer: No, it is difficult to understand questions that are not related to my work day. Many questions are at NTNU level.

Is it OK to publish answers?

- Answer: Yes

16.12 Interview with Carl-Fredrik Soerensen, NTNU IT-Architect

The NTNU IT-Division is organized in the central administration under the NTNU Organization Director. And counts about 100 employees. The main responsibilities for NTNU IT-Division are (5):

- IT operations for common and basis services for NTNU.
- Develop web based solutions for NTNU.
- Advisory activities for the NTNU organization in IT.

Carl-Fredrik Soerensen, NTNU IT-Division/Department of Computer and Information Science, IT-Architect/Senior Lecturer, 24. October 2014.

Email: carl-fredrik.sorensen@ntnu.no

Question no.	NTNU ICT-Architect 1 strategic level answers	Score
1	a and mostly c. Customers: Students, Companies, Partners and Principals. No customers across. No CRM. Suppliers of COTS are shared, not for service suppliers.	1
2	c. However there is a divide on economy and for FS management	1
3	mostly c and some b	1
4	d and some c	1
5	Partly a, b(Student and Academic division, HR) and c	1
6	c and d	1
7	Some c, else there is anarchy	1
8a	low	1
8b	low	1
9	Question not asked (test)	0
9a	Question not asked (test)	0
10	Question not asked (test)	0
10a	Question not asked (test)	0
11	Question not asked (test)	0
12	Question not asked (test)	0
	Strategic level score	9

Table 16.43: NTNU ICT-Architect 1 strategic level survey

Question no.	NTNU ICT-Architect 1 tactical level answers	Score
1	NTNU concentrates on IT-operations processes. Not about design and strategy. TOGAF is not anchored as a steering model, but used guideline. The It management does not wish to be governed by a framework as TOGAF.	0,5
1a	Little	0,5
1b	ITIL to some degree	0,5
2	Studies, research, innovation, communication and HR/Economy	1
2a	IAM supports HR	1
3	The IT-Board (Directors for organization, IT, Economy and Pro-Rector for Education). NB! IT for the Central Administration og NTNU not research and innovation.	1
3a	Programs are established without frames and budget, but as an organizational form. Program leaders are project managers not business leaders. (Operative not strategical).	1
3b	We have the committee of IT operations and the IT-operations meeting.	1
4	Business units. Eg. HR own the IAM process.	1
5	The business units/areas own the data. Not the Central Administration? (Normally Director of Organization)	1
5a	No	0
6	Business units	1
7	-	0
7a	-	0
7b Process	Not existing	0
7b Application	The committee of IT operations	1
7b Technology	The committee of IT operations	1
8	No	0
8a	No	0
8b	There is not portfolio management for IT-operations.	0
9	No	0
9a	No	0
9b	No	0
10	Have made target architecture, no gap analysis	0,5
11	No	0
12	Yes for development. Maybe for governance for IT-Board?	0,5
13	No	0
13a	Na	0
14	No	0
15	No	0
16	No	0

Table 16.44: NTNU ICT-Architect 1 tactical level survey

Question no.	NTNU ICT-Architect 1 tactical level answers	Score
17	ISO 27000	1
17a	No	0
18	No	0
18a	Na	0
19	No	0
19a	It should describe: Role, responsibility, knowledge and authority. There is no cohesion. Eg. Who has the knowledge which defines a student?	0
19b	Na	0
20	No	0
20a	Na	0
21a	DIFIs principles	1
21b	Yes, referring to architecture wiki.	1
21c	Yes, DIFI	1
21d	No	0
22a	Yes	1
22b	No	0
23a	Persons or roles setting requirements has to do it. Usually a person from IT-Department.	1
23b	No, to a small degree	0
23c	None	0
23d	No	0
24	Privacy act.	1
	Tactical level score	19,5

Table 16.45: NTNU ICT-Architect 1 tactical level survey (continues)

Question no.	NTNU ICT-Architect 1 operational level answers	Score
1	Yes, partly	
2	Yes, partly but not in systems.	
3	Yes, but not followed	
3a	Yes partly, but not followed	
3b	Yes partly, but not followed	
3c Data	Yes	
3c Application	Partly	
3c Process	No	
3c GUI	Yes, partly, by person setting requirements.	
3d	Yes, not good.	
3e	Partly, push and pull protocols.	
4	-	
4a	Yes, partly -Z operations (check)	
4b	Yes, partly. Change is in the Transition Process. Lacking Strategy, design and continuous Improvement.	
5	Yes	
5a	Yes	
5b	Yes	
5c	Yes, Cfengine	
6	Fire fighting.	
7	Reactive	
8	This is unclear	
	Tactical level score	13

Table 16.46: NTNU ICT-Architect 1 tactical level survey (continues)

Further questions and comments, Carl-Fredrik Soerensen:

Where the questions asked relevant?

- Answer: This question were not asked as this was primary a test survey. And The questionnaire is at this point still is under development. The answers still are interesting.
- However, Carl-Fredrik thought the questions asked can be used as basis for an automated and large scale questionnaire.

Is it OK to publish answers?

- Answer: Yes

16.13 Interview with Ole Ingvard Langfeldt, NTNU IT-Architect

The NTNU IT-Division is organized in the central administration under the NTNU Organization Director. And counts about 100 employees. The main responsibilities for NTNU IT-Division are (5):

- IT operations for common and basis services for NTNU.
- Develop web based solutions for NTNU.
- Advisory activities for the NTNU organization in IT.

Ole Ingvard Langfeldt, NTNU IT-Division, IT-Architect, 27. October 2014

Email: ole.langfeldt@ntnu.no

Question no.	NTNU ICT-Architect 2 strategic level answers	Score
1	a	
2	a	
3	all	
4	a	
5	a and c	
6	c	
7	c. No control over decisions related to infrastructure. Dont know for applications	
8a	Low	
8b	Low	
9	Question not asked (test)	
9a	Question not asked (test)	
10	Question not asked (test)	
10a	Question not asked (test)	
11	Question not asked (test)	
12	Question not asked (test)	
	Strategic level score	9

Table 16.47: NTNU ICT-Architect 2 strategic level survey

Question no.	NTNU ICT-Architect 2 tactical level answers	Score
1	ITIL, operational	1
1a	To a large degree, bur not for every faculty.	1
1b	Its ok as long we deliver better services.	1
2	Education, Communication, Research, Innovation and Central Administration/Management	1
2a	Education, Communication, and Central Administration/Management	1
3	Distributed and centralized. Is in change.	1
3a	PAM project model	1
3b	None	0
4	Dont know	0
5	Persondata, Organization Director. Else the system owner owns the data.	1
5a	Yes, however the organization dont know that. It is not practised.	1
6	All	0
7	No formal processes, Ad-hoc.	0,5
7a	-	
7b Process	Unclarified	0
7b Application	Attempt with the IT-board	0,5
7b Technology	Unclarified, using projects as tool	0,5
8	No	0
8a	Dont know	0
8b	No	0
9	No	0
9a	Dont know	0
9b	No	0
10	Work started	0,5
11	No	0
12	No	0
13	No	0
13a	Na	0
14	No	0
15	No	0
16	No	0
17	ISO 27000	1
17a	Yes	1

Table 16.48: NTNU ICT-Architect 2 tactical level survey

Question no.	NTNU ICT-Architect 2 tactical level answers	Score
18	We have not realized the potential regarding TIA.	1
18a	To a small degree.	1
19	No	0
19a	Na	0
19b	Na	0
20	No	0
20a	No	0
21a	DIFIs	1
21b	Yes	1
21c	Yes, Web-Services	1
21d	No	0
22a	Yes	1
22b	-	0
23a	Yes, Economy division manages contracts.	1
23b	None	0
23c	Bad system	1
23d	No, not good at that	0
24	Privacy Act and personal privacy regulations.	1
	Tactical level score	22

Table 16.49: NTNU ICT-Architect 2 tactical level survey (continues)

Question no.	NTNU ICT-Architect 2 operational level answers	Score
1	Yes	
2	There is a principle document. And it is executed.	
3	Dont know other than TIA, Web-Services and Kjernen.	
3a	Yes	
3b	Yes	
3c Data	Yes	
3c Application	Yes	
3c Process	No work flow engine.	
3c GUI	Yes, Innsida	
3d	Yes	
3e	Yes	
4	ITIL	
4a	Yes + problem	
4b	Yes	
5	Yes	
5a	Yes	
5b	Yes	
5c	Blank	
6	Dont know	
7	Reactive	
8	Only the NTNU Communication division takes ownership.	
	Operational level score	22

Table 16.50: NTNU ICT-Architect 2 operational level survey (continues)

Further comments:

Where the questions asked relevant?

- Answer: Some are relevant and some are not.

Is it OK to publish answers?

- Answer: Yes

Appendix D

Comparison of the 3 best practices Statkraft, Sykehusparner and Statoil are in figure 4.1 defined as the enterprises with the best integration practices. The tables below compares the 3 best practices at strategic, tactical and operational level.

Table 16.51: Best practice comparison, strategic level

No.	Statkraft	Sykehuspartner	Statoil
Strategic level			
1	c	a	a
2	b	a	b and d
3	b	a	b
4	b	b	b and d
5	a and b	b	b
6	d	d	d
7	b and c	b	b
8a	High, to a large degree.	High	High
8b	High, can be improved.	High	High
9	Yes	Yes	Yes
9a	Yes	Yes	Yes
10	Yes	Yes	Yes
10a	Yes	Yes	Yes
11	Yes	Not easy to answer	Yes, because of production targets and other targets
12	Overall guidelines from the corporation. For MIDI, IT follow-up	Visions, goals, national guidelines.	The Statoil Strategy, technology, exploration, project portfolio, external trends as: Big Data, Open Link Data and Consumerisation. This drives IT-strategy, technology and exploration strategy, again supported by IT-strategy that again supports business strategy.

Table 16.52: Best practice comparison, tactical level

No.	Statkraft	Sykehuspartner	Statoil
Tactical level			
1	TOGAF in a source of inspiration for EA. For infrastructure: ITIL	ITIL, TOGAF and Gartner SOA Center of Excellence	TOGAF has been applied as framework for EA work at general basis. COBIT is removed.
1a	ITIL to a large degree.	ITIL and TOGAF is well implemented.	DO not have much IT-Governance now. Use ITIL.
1b	For ITIL: Common terminology. For TOGAF: Common terminology for architecture.	A way of structuring how the enterprise operate.	The activities in TOGAF are distributed over the existing governance structure.
2	Marketing/trading, power generation, international power generation, HR, economy and finance.	ICT-Services, Project Services, HR, Purchase and Logistics.	Exploration, petroleum technology, well drilling, project development, operations and maintenance, marketing and supply.
2a	Most core processes, some for power generation.	ICT-Services, Purchase and Logistics.	All
3	Strategic, tactical and operational. Priority board/meeting: Representatives from HR, economy and finance at lower level. However, they have decision authority!	Y-model. See figure and definitions in Appendix A.	The IT-Arena process.
3a	Project portfolio board. Corporate and IT-level.	Project portfolio management.	Same as above

No.	Statkraft	Sykehuspartner	Statoil
3b	Priority board/meeting	Own operational management organization.	Same as above. Does not distinguish between projects and IT-operations.
4	CEO own the processes. Manager for business unit is responsible.	The director, the line organization own the processes.	The process owners in the line organization.
5	The business side own the data	The Health Authority own the data.	The line organization.
5a	No, problem identified. Goal not reached so far.	Yes, is defined by Norwegian legislation.	Yes, one cannot create data i Statoil without first defining ownership.
6	Business units Statkraft	The patient, RHF and Ministry of Health and Care Services	Process owners and corporate directors.
7	Priority board/meeting can be an arena. Process owner has delegated decision authority.	Strategies and long term planning. Process owners RHF and data owner HF.	Yes, steering coordinators which are the process owners longer arm in the line organization.
7a	-	Regional organizing is clear and well defined. Regional Health Authority (RHF) has taken control.	Steering coordinator.
7b Process	Business side	Coordinated from RHF.	Decisions made by process owners. The steering coordinator introduce the process in the line organization.
7b Appli- cation	Business side	SP	Application changes are done by the product owners. For deployment of changes in the applications in the large business areas the steering coordinator plays a role. This often implies changes in work form and work routines. Therefore the steering coordinator must be involved. And then there is the steering coordinator network.
7b Tech- nology	IT	SP	IT-Arena

No.	Statkraft	Sykehuspartner	Statoil
8	Yes	Yes	Yes, We have the Product Area Board. Within a domain as e.g. exploration the Product Area Board is responsible for the portfolio management within its product area such as eco systems and products belonging together.
8a	Yes	Yes	Yes, Product Area Board.
8b	Priority board/meeting	Yes	Yes, Product Area Board. This is really a DevOps implementation organization. It is up-scaled to function in a large organization. It is called: Product Owner, Product Area Board and Product Life Cycle Team, but it is really an implementation of DevOps. It was introduced 1. April this year, so it's new. Before it was chaos and coordination..
9	See below	Yes	Yes, Product Life Cycle Team (PLC-team)
9a	Yes and no. Must be better	Yes, absolutely	PLC-team (Called DevOps in the rest of the world)
9b	Yes and no. Must be better.	Yes, absolutely	Yes, this is PLC-team responsibility. They shall have a road-map to handle it.
10	Yes, for security, integration and the most important questions.	Yes	Yes, for product and product area
11	No. However it is defined.	Yes, we do have some KPIs for that purpose.	Yes, we are now moving from a project and IT-operations model to a DevOps model. We have a target governance model for DevOps. However, we are not there, yet.
12	Yes and yes	Yes, mostly operational management team. Also for projects.	Yes

No.	Statkraft	Sykehuspartner	Statoil
13	Yes for SOA. For governance, adapted standard framework.	Yes, loud and clear.	Yes, each for PLC-team. Shall hold an overview over how training is carried out.
13a	For SOA: Using external training suppliers. Plus programs (Training plan ie. sessions with HR and business side)	Courses, formal process for hand-over, documentation, solutions, guidelines and routines.	Each PLC team shall hold an overview over how training is carried out.
14	Dont know	Yes, for the integration area, not for business area.	Yes all the time. There is an own process describing process transitions.
15	No, pragmatic approach. Roadmap at system level.	Yes, a clear cloud based virtualisation strategy.	Yes
16	Dont know	Yes, for integrations is a plan defined. 24. November there is Kick-off for Center of Excellence.	The organization is in continuous change. However, there is hardly a superior plan.
17	Using following practice: Risk manager, integration security architect and emergency plan.	ISO 27001 and Own unit for security	Several risk management hand books and main handbook.
17a	Na	Yes. At some areas there are exceptions.	Yes, High focus on compliance and leadership.
18	Yes	Yes	Service orientation has lead to increased agility. It has lead to improved re-use of services than before. Whether Enterprise architecture (EA) and governance have contributed to increased agility, the answer is no. EA does not in it self lead to improved agility. EA and Governance is implemented for control and cost-reduction.
18a	To a large degree. More effective and faster response time.	Yes, to a very large degree!	Se above.

No.	Statkraft	Sykehuspartner	Statoil
19	Some, lack of model	Yes	Yes
19a	Na	Yes, for the health care sector this is clearly defined.	The most dominant information objects in Statoil, its ownership and where the master data is placed.
19b	Na	Yes. Eg. a patient is clearly defined.	Yes
20	We have several models. This should be improved and should perhaps be prioritized.	Yes, for different business areas.	Yes
20a	Who is responsible for data. What data within the area is important for systems. Describe where master shall be.	See above	Did not find the description.
21a	Yes, Integration principles approved. Enterprise architecture work started: Information architecture, Enterprise architecture	Yes, DIFI	Yes, described in the Statoil Management System.
21b	See above	Yes	Yes, same as above.
21c	Yes	See above	Yes, same as above.
21d	Yes. Broken window principle.	Yes	Yes, same as above.
22a	Yes	Yes, but complex. General IT-service hierarchy.	Yes, there is a price model for everything.
22b	Have a model	Mostly no, some for SMS messages.	No, however the prices are followed-up by the procurement/purchase department.
23a	Yes	Yes, to a large degree.	Yes, the procurement/purchase organization.
23b	Priority board/meeting	Solved by operational management organization.	Product Area Board and process owners.
23c	Priority board/meeting	There is a line function/unit in SP working with processes.	The line in the business unit.
23d	Yes, however not always.	Yes, try to get away from personal dependencies.	Yes
24	Privacy act	Privacy act, Patient legislation and Patient care legislation.	The local legislation as Statoil operates in more than 40 countries.

Table 16.53: Best practice comparison, operational level

No.	Statkraft	Sykehuspartner	Statoil
1	Yes	Yes	PLC-team and platform team. A PLC-team is responsible for a product. Eg. Reporting and Trading System (RATS). While a platform team is responsible for delivering platform services as database. Platform as Service.
2	Yes, is being composed now.	Yes, level classification and context model	Yes, is described in a Information Management document as well as Information Security. It says something about how classification of information i different classification levels shall be handled.
3	Yes	Yes	Yes, guidelines described in governance document. Detailed integration principles are defined in each PLC-team and Product Area Board for the Ecosystems. This because principle details for integrations are Ecosystem dependent. Having guidelines described in governance document and detailed integration principles defined at a lower level make it possible to avoid conflicts concerning architecture perceptions. Breach of guidelines must be reasoned.
3a	Yes, some	Yes	Requirements and guidelines are implemented in each PLC-team.
3b	Yes, what is the distinction between SOA and software?	Yes	Requirements and guidelines are implemented in each PLC-team.

No.	Statkraft	Sykehuspartner	Statoil
3c Data	Yes	Yes	Yes, ETL integrates operative, tactical and strategic systems such as RATS and for data warehouse purposes. Do prefer REST at integration method. Do not prefer orchestration solutions such as Oracle Fusion Middelware and database links.
3c Application	Yes	Yes	Yes, REST, Biztalk and MQ
3c Process	Yes	Yes	Yes, many Ecosystems are delivered with a work flow engine such as SAP. That kind of tool has an important function in an ecosystem. If a transaction starts in an ecosystem and is handed over to an another ecosystem. There probably will be a technology change between ecosystems. And there probably will be a transaction hand shake handover to the next ecosystem. The transaction probably will live in several ecosystems. Eg. a transaction is handed over from RATS to SAP. There are clear borders for business processes and IT-systems. The IT-system shall not pass the border for the business process. An important principle is to information borders and process borders shall follow each other. This is described in Statoil Governance document Appendix B? (27).

No.	Statkraft	Sykehuspartner	Statoil
3c GUI	Yes	Yes	Yes, there are many portals, but no uber-portal.
3d	Yes, there are some reasoned exceptions	Yes	Yes, try to get away from that.
3e	Separate unit. Dont know.	Na	Yes
4	ITIL, Scrum and Canban.	Incident, Change, Problem, Service request (varying degrees). Started to look at life cycle management.	Yes, most processes
4a	Yes	Yes	-
4b	Incident, change, problem and service request.	Yes	-
5	Yes	Yes	Yes, however not all teams are equally clever.
5a	Yes, Subversion	TFS, Microsoft Team Foundation	Yes
5b	Yes, Team City and N.Ant.	TFS	Yes, Git and Jenkins
5c	Biztalk Deployment framework	TFS	Don't know. CMDB has tools.
6	Firefighting in Statkraft. To a less degree now than before.	Daily routines and follow-up.	Coordination
7	Proactive to a large degree.	Mostly proactive. Some old legacy.. Regional monitoring.	Very reactive. This caused by the Service Management process in ITIL. Must monitor every incident.
8	Business side decides. IT take responsibility.	Moved to RHF-level. Core processes. Goes in direction of more centralization.	Product Owner and the Product Area Board.

Appendix E

Qualitative analysis of the best practice enterprises This appendix contains a qualitative analysis of the best practice enterprises comparison of Sykehuspartner, Statoil and Statkraft appendix D. The analysis are at strategic, tactical and operational level. In this qualitative analysis of best practice enterprises there are some interesting practice worth notice from other enterprises in the survey as well (Appendix B). These are marked: "Interesting practice" in this analysis. Please note the Qualitative analysis will colored by my personal point of view.

16.14 Strategic level analysis

The main analysis of strategic level for the enterprises in the survey is displayed in figure 4.1 p??.

Table 16.54: Strategic level analysis

Strategic level questions	Answers
1. Do the enterprise have shared customers and suppliers?	See figure 4.1
2. Transactions?	See figure 4.1
3. Business units and operations?	See figure 4.1
4. Management?	See figure 4.1
5. Design of business processes?	See figure 4.1
6. Sharing of data?	See 4.1
7. IT-decisions?	See figure 4.1
8. Operational model?	See figure 4.1
9. Is there a strategy and vision for the enterprise?	Yes, for all best practice enterprises.
10. Is there a strategy and vision for IT?	Yes, for all best practice enterprises.
11. Is there a red line from strategy to operations?	Best practice enterprises mostly have a red line. Statoil and Statkraft have a red line. For Sykehuspartner it is not easy to answer.
12. What gives input to strategic management of IT?	Best practice is varying to a large degree. E.g: Technology, trends, project portfolio, visions, goals, guidelines, and business strategy .

16.15 Tactical level analysis

Best practice examined by...: (Not NTNU)

Table 16.55: Tactical level analysis

Tactical level questions	Best practice tactical level analysis
<p>1. What frameworks are implemented? E.g. ITIL, COBIT or TOGAF?</p>	<ul style="list-style-type: none"> ● Best practice enterprises have implemented ITIL to a large degree. ● TOGAF is either implemented or TOGAF guidelines are used in enterprises to a larger degree. ● E.g: Statoil has removed COBIT as it was overlapping with TOGAF. Now the activities in TOGAF are distributed over existing governance structure, the Management Architecture. ● Sykehuspartner has implemented Gartners SOA Center of Excellence.
<p>2. What is the core enterprise processes?</p>	<ul style="list-style-type: none"> ● This variate from enterprise to enterprise. E.g. For Statkraft these are: Marketing/trading, power generation, international power generation, HR, economy and finance.
<p>3. What IT-decision model is implemented?</p>	<ul style="list-style-type: none"> ● The federal model - Combination of the corporate center and business units with or without IT-people involved (1, p. 17), represents best practice. ● Interesting practice: USIT have an principle about delegate IT-decisions to the lowest possible level (93) - IT duopoly decision model (1, p. 17).

Tactical level questions	Tactical level analysis
4. Who own the processes?	<ul style="list-style-type: none"> • The line or top manager own the processes. The responsibility is often delegated to business units or professional departments. The difference is whether the line conduct an active ownership. • E.g. for Statkraft: CEO own the processes. Manager for business unit is responsible.
5. Who own the data?	<ul style="list-style-type: none"> • The business side or line organization owns the data. For the Sykehuspartner the Health Authority owns the data. • Data ownership is for Statoil and Sykehuspartner (health sector) well defined. For statkraft this problem is identified.
6. Which stakeholders exist for the core processes?	<ul style="list-style-type: none"> • This variate from enterprise to enterprise. E.g. For Statkraft these are: Marketing/trading, power generation, international power generation, HR, economy and finance.
7. How does the stakeholders (data and process owners) interact?	<ul style="list-style-type: none"> • A federal decision model (1, p. 17) or similar is most common. In Statkraft priority board/meeting can be an arena. Process owner has delegated decision authority. • Process decisions are done by by process owners or business side, Federal decision model. • Process decisions are done by by product owners or business side, Federal decision model. • Technology decisions done by by the IT-department or business side (IT Monarchy or Federal decision model). • Interesting Practice: For University in Oslo/USIT: The entire enterprise (Faculties+administration) is represented in SCAIT (93), federal decision model.

Tactical level questions	Tactical level analysis
8. IT portfolio management?	<ul style="list-style-type: none"> ● All best practice enterprises have portfolio management regarding programs and projects. ● Note: Statoil does not difference in portfolios for projects and IT-operations. Statoil are implementing the DevOps model (95) to a large degree. ● Interesting practice: UIO/USIT budget their projects including IT-operations. This practice at UIO/USIT is reasoned by motivation for change and innovation.
9. Portfolio management and life cycle management for systems?	<ul style="list-style-type: none"> ● Sykehuspartner and Statoil has cycle management. Statkraft has room for improvements. ● Sykehuspartner has life cycle cost model for core systems and life cycle status: System, product, solution or component in or out. ● Statoil has implemented Product Life Cycle Team (PLC-team). Called DevOps (95) in the rest of the world. Managing life cycle cost and life cycle status.
10. Target architecture, road map and gap analysis?	<ul style="list-style-type: none"> ● Yes, Best practice enterprises do have target architecture, road map and gap analysis.
11. Target governance model?	<ul style="list-style-type: none"> ● Best practice enterprises mostly have target governance models. ● Sykehuspartner has KPIs for that purpose. ● Statoil has DevOps as target governance model.
12. Development and governance teams?	<ul style="list-style-type: none"> ● All best practice enterprises have development teams. ● Statoil and Statkraft have a governance teams.

Tactical level questions	Tactical level analysis
13. Programs for SOA and Governance training/education?	<ul style="list-style-type: none"> • Sykehuspartner has courses, formal process for hand-over, documentation, solutions, guidelines and routines. • Statkraft use external training suppliers. Plus programs (Training plan ie. sessions with HR and business side). • For Statoil each PLC team shall hold an overview over how training is carried out.
14. Process transition plan?	<ul style="list-style-type: none"> • For best practice enterprises for process transition plans are varying. • Sykehuspartner use process transition plan for the integration area. • Statoil: Yes all the time. There is an own process describing process transitions.
15. Technology transition plan?	<ul style="list-style-type: none"> • Best practice enterprises do have process transition plans. • Statkraft use pragmatic approach. Roadmap at system level. • Sykehuspartner has a clear cloud based virtualization strategy. • Statoil has a technology transition plan.

Tactical level questions	Tactical level analysis
16. Organization transition plan?	<ul style="list-style-type: none"> • For best practice enterprises organization transition plans practice are varying. • For Sykehuspartner this plan for integrations was defined. 24. November there was Kick-off for Center of Excellence. • For Statoil the organization is in continuous change. However, there is hardly a superior plan. • Interesting practice: UIO/USIT and the large commercial supplier of IT infrastructure have a organization transition plan.
17. Risk management/security?	<ul style="list-style-type: none"> • Best practice enterprises have implemented security and risk management. • Sykehuspartner use ISO 27001/2 and has an own unit for security. • Statoil have Several risk management hand books and main handbook.
18. Has transition to new integration technology as SOA, Enterprise Architecture and IT-Governance lead to increased agility and opportunities to develop new services and products. I.e. increased competitiveness and shorter time-to-market?	<ul style="list-style-type: none"> • Yes, Sykehuspartner and Statkraft have experienced increased agility and increased competitiveness shorter time to market. • I learned this question might not be very specific. Therefore the Statoil answer is interesting: Service orientation has lead to increased agility. It has lead to improved re-use of services than before. Whether Enterprise architecture (EA) and governance have contributed to increased agility, the answer is no. EA does not in it self lead to improved agility. EA and Governance is implemented for control and cost-reduction.

Tactical level questions	Tactical level analysis
19. Information model?	<ul style="list-style-type: none"> • Yes, best practice enterprises mostly have defined information models. • Sykehuspartner has information models: For the health care sector this is clearly defined. • Statoil has the most dominant information objects described, its ownership and where the master data is placed. • Statkraft has some described. • Interesting practice: Bank IT-operations is in preparation. Some work done on basis data. Impossible to define only one information model.
20. Master data model?	<ul style="list-style-type: none"> • For best practice enterprises the for master data model work is well established. • Statkraft: Who is responsible for data. What data within the area is important for systems. Describe where master shall be.
21. Governance documents describing:	
21.(a) Architecture principles?	<ul style="list-style-type: none"> • Yes, best practice enterprises have architecture principles approved or under work. • For Sykehuspartner the public sector DIFIs principles are applied. • E.g. Statkraft has Integration principles approved. Enterprise architecture work started: Information architecture, Enterprise architecture and security. • For Statoil architecture principles are described in the Statoil Management System.
21.(b) Architecture requirements regarding purchase, procurement or development?	<ul style="list-style-type: none"> • Yes, approved and defined for best best practice enterprises.

Tactical level questions	Tactical level analysis
21.(c) Integration requirements?	<ul style="list-style-type: none"> • Yes, approved and defined for best best practice enterprises.
21.(d) Policy regarding legacy/technical dept?	<ul style="list-style-type: none"> • Best practice enterprises do have policy regarding legacy/technical dept. • E.g. Statkraft use the Broken Window principle (37). • Interesting practice: For Bank IT-operations the IT Operations management organization is very conscious about this. However, this depends on the system responsible. There might be different policies from system to system.
22. Price model?	
22.(a) General price model for IT-services?	<ul style="list-style-type: none"> • Yes, best practice enterprises do have a price models for IT-services.
22.(b) Price model for information/data-transactions/web-services?	<ul style="list-style-type: none"> • For best practice enterprises the practice is varying: • Statkraft do have a model, Sykehuspartner has a price model for SMS messages and for Statoil prices are followed-up by the procurement/purchase department. • Interesting practice: The Health sector price SMS messages and price information exchange against external enterprises as the primary health care. • Interesting practice: For a bank 95 percent of the transactions come from the internet bank portal. In a bank a everything is charged.
23. Governance:	
23.(a) Tender and contracts?	<ul style="list-style-type: none"> • Yes, all best practice enterprises use tender and contracts. Some are determined by government regulations. • Statoil has procurement/purchase organization.

Tactical level questions	Tactical level analysis
23.(b) How are enterprise processes, IT-systems and integration associated?	<ul style="list-style-type: none"> ● Best practice enterprises uses Business side or process owners. Federal decision model. ● Statkraft has a Priority board/Meeting. ● Intertsting practice: The large commercial supplier of IT infrastructure has a Sales Management Team and Business Unit Matrices Management Team. ● Intertsting practice: For Bank It Operations: Most changes are project based and anchored by the system owner and system responsible.
23.(c) Who receive process change suggestions or initiatives?	<ul style="list-style-type: none"> ● For best practice enterprises initiatives are received by the business side or line organization. ● For Sykehuspartner there is a line function/unit working with processes.
23.(d) Does one distinguish enterprise (what is done) and organization (who does)?	<ul style="list-style-type: none"> ● Yes most enterprises does distinguish.. ● E.g. UIO/USIT has implemented a service orientation in the central administration.
24.What law or legislation are guidelines for information and integration?	<ul style="list-style-type: none"> ● For Statkraft: The Privacy Act (Personvernloven) ● For Sykehuspartner: Privacy act, Patient legislation and Patient care legislation. ● For Statoil: The local legislation as Statoil operates in more than 40 countries.

16.16 Operational level analysis

For the enterprises in the survey indicate that the experiences and practice at operational level are quite similar to a large degree. Therefore there will not be much focus at this level. Still it is important to state the actual practice at operational level. I think this observation supports the view given in figure 2.?? (sjekk) IT-Governance and IT management and thereby IT governance mostly concern the strategic and tactical level concerns.

Table 16.56: Operational level analysis

Operational level questions	Operational level analysis
1.Organization divided in development and IT-operations?	<ul style="list-style-type: none"> • Best practice enterprises divide development and IT-operations except Statoil. • Statoil is using Product life Cycle (PLC) team and platform team. A PLC-team is responsible for a products development and operations. The PLC team is the Statoil implementation of a DevOps team (28). While a platform team is responsible for delivering platform services as database. Platform as Service.
2. Classification of information and security?	<ul style="list-style-type: none"> • Yes for all best practice enterprises • E.g. Sykehuspartner has level classification and a context model. • Statoil has Information Management document as well as Information Security. It says something about how classification of information i different classification levels shall be handled. • Interesting practice: UIO/USIT has some research communities require extremely secure environments. Such as TSD: Services for Sensitive Data, an USIT project.

Operational level questions	Tactical level analysis
3. Principles for integration?	<ul style="list-style-type: none"> • All best practise enterprises have principles for integration described. • Statoil has guidelines described in governance document See Appendix I. Detailed integration principles are defined in each PLC-team and Product Area Board for the Ecosystems (reference?harald?). This because principle details for integrations are Ecosystem dependent. Having guidelines described in governance document and detailed integration principles defined at a lower level make it possible to avoid conflicts concerning architecture perceptions. Breach of guidelines must be reasoned.
3.(a) Requirements for integrations? Such as SOA principles.	<ul style="list-style-type: none"> • Yes, best practice enterprises have principles or guidelines described.
3.(b) Requirements for software integrations?	<ul style="list-style-type: none"> • Yes, best practice enterprises have principles or guidelines described.

Tactical level questions	Tactical level analysis
3.(c) Which types of integration methods are performed? And at what level?	<ul style="list-style-type: none"> ● Statoil represents a best practice: <ul style="list-style-type: none"> – Data: ETL integrates operative, tactical and strategic systems such as RATS and for data warehouse purposes. Do prefer REST at integration method. Do not prefer orchestration solutions such as Oracle Fusion Middleware and database links. – Application: REST, Biztalk and MQ. – Process: Yes, many Ecosystems are delivered with a work flow engine such as SAP. That kind of tool has an important function in an ecosystem. If a transaction starts in an ecosystem and is handed over to an another ecosystem. There probably will be a technology change between ecosystems. And there probably will be a transaction hand shake handover to the next ecosystem. The transaction probably will live in several ecosystems. Eg. a transaction is handed over from RATS to SAP. There are clear borders for business processes and ITsystems. The IT system shall not pass the border for the business process. An important principle is: Information borders and process borders shall follow each other. This is described in Statoil Governance document Appendix I (27)). ● Interesting practice: Most enterprises in the survey have following integration types: Data integrations as ETL, integrations at application level and GUI integrations, such as portals. Some enterprises have process integrations, such as work flow.
3.(d) Run time dependencies such as database link?	<ul style="list-style-type: none"> ● Best practice enterprises have run time dependencies. Statkraft has some exceptions and Statoil try to get away from it (tidy-up).

Tactical level questions	Tactical level analysis
3.(e) Business Intelligence. Data flow from local data warehouse to corporate data warehouse?	<ul style="list-style-type: none"> ● For best practice enterprises this question only was relevant for Statoil which answer is yes.
4. Framework for IT-operational processes such as ITIL?	<ul style="list-style-type: none"> ● Best practice enterprises have implemented ITIL. Most common processes implemented are: Change, Problem and incident. ● In addition Statkraft use Canban and Scrum.
5. Revision control, building and distribution of software?	<ul style="list-style-type: none"> ● Yes, this is well established in best practice enterprises. Interesting practice: This apply for all enterprises in the survey.
6. What type of IT-operations take most resources and energy?	<ul style="list-style-type: none"> ● This variates for best practice enterprises to a large degree: From Firefighting, Daily routines/follow-up and Coordination.
7. Re-active or pro-active IT operations?	<ul style="list-style-type: none"> ● Best practice varies. ● Statkraft and Sykehuspartner is mostly pro-active. ● Statoil is very reactive. This caused by the Service Management process in ITIL. Must monitor every incident.
8. Ownership to larger IT-services? Who?	<ul style="list-style-type: none"> ● For best practice enterprises business side takes ownership is most common.

Appendix F

16.17 TOGAF and ITIL

This appendix provide a short description of TOGAF and the NTNU IT Division ITIL processes.

16.18 TOGAF

The core concepts of TOGAF in this appendix are defined in the "Open Group Standard - TOGAF Version 9.1" (45). TOGAF is an architecture framework. TOGAF provides the methods and tools for assisting in the acceptance, production, use, and maintenance of an enterprise architecture. It is based on an iterative process model supported by best practices and a re-usable set of existing architecture assets (45).

16.18.1 What is Architecture in the Context of TOGAF?

In TOGAF, "architecture" has two meanings depending upon the context (45):

1. A formal description of a system, or a detailed plan of the system at component level to guide its implementation.
2. The structure of components, their inter-relationships, and the principles and guidelines governing their design and evolution over time.

16.18.2 What Kind of Architecture Does TOGAF Deal With?

There are four architecture domains that are commonly accepted as subsets of an overall enterprise architecture, all of which TOGAF is designed to support (45):

- The Business Architecture defines the business strategy, governance, organization, and key business processes.
- The Data Architecture describes the structure of an organizations logical and physical data assets and data management resources.
- The Application Architecture provides a blueprint for the individual applications to be deployed, their interactions, and their relationships to the core business processes of the organization.

-
- The Technology Architecture describes the logical software and hardware capabilities that are required to support the deployment of business, data, and application services. This includes IT infrastructure, middleware, networks, communications, processing, standards, etc.

16.18.3 TOGAF - consist of

TOGAF consist of following (67):

- An Architectural Development Method (ADM)
- Foundation Architecture
 - A Technical Reference Model (TRM)
 - A Standards Information Base (SIB)
 - Building Blocks Information Base(BBIB)
- Resource Base contains advice on:
 - Architecture views, IT Governance, Business scenarios, Architecture patterns, etc.

16.18.4 Architecture Development Method

The TOGAF Architecture Development Method (ADM) provides a tested and repeatable process for developing architectures. The ADM includes establishing an architecture framework, developing architecture content, transitioning, and governing the realization of architectures.

All of these activities are carried out within an iterative cycle of continuous architecture definition and realization that allows organizations to transform their enterprises in a controlled manner in response to business goals and opportunities. Phases within the ADM are as follows (45):

- The **Preliminary Phase** describes the preparation and initiation activities required to create an Architecture Capability including customization of TOGAF and definition of Architecture Principles.
- **Phase A: Architecture Vision** describes the initial phase of an architecture development cycle. It includes information about defining the scope of the architecture development initiative, identifying the stakeholders, creating the Architecture Vision, and obtaining approval to proceed with the architecture development.
- **Phase B: Business Architecture** describes the development of a Business Architecture to support the agreed Architecture Vision.
- **Phase C: Information Systems Architectures** describes the development of Information Systems Architectures to support the agreed Architecture Vision.

- **Phase D: Technology Architecture** describes the development of the Technology Architecture to support the agreed Architecture Vision.
- **Phase E: Opportunities Solutions** conducts initial implementation planning and the identification of delivery vehicles for the architecture defined in the previous phases.
- **Phase F: Migration Planning** addresses how to move from the Baseline to the Target Architectures by finalizing a detailed Implementation and Migration Plan.
- **Phase G: Implementation Governance** provides an architectural oversight of the implementation.
- **Phase H: Architecture Change Management** establishes procedures for managing change to the new architecture.
- **Requirements Management** examines the process of managing architecture requirements throughout the ADM.

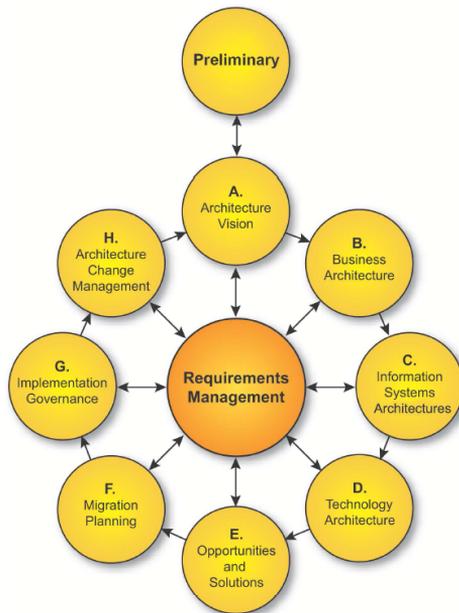


Figure 16.2: TOGAF ADM

16.19 NTNU IT Division ITIL processes

- **Service desk**
Tasks include handling incidents and requests, and providing an interface for other ITSM processes.
- **Change management**
Change management aims to ensure that standardized methods and procedures are used for efficient handling of all changes.
- **Incident management**
Incident management aims to restore normal service operation as quickly as possible and minimize the adverse effect on business operations.
- **Problem management**
Problem management aims to resolve the root causes of incidents and thus to minimise the adverse impact of incidents and problems on business that are caused by errors within the IT infrastructure, and to prevent recurrence of incidents related to these errors.
- **Service level management**
Service-level management provides for continual identification, monitoring and review of the levels of IT services specified in the Service-level agreements (SLAs).
- **Security**
The ITIL-process Security Management describes the structured fitting of information security in the management organization.

Appendix G

16.20 Enterprise Model and Architecture As-Is

This Appendix describes Enterprise Model and Architecture As-Is supported by TOGAF presenting different architectural views. Focus is at TIA case, actual NTNU practice for enterprise architecture and actual NTNU practice IT Governance.

16.20.1 NTNU legacy integration system As-Is

This subsection describes NTNU legacy integration system As-Is (Kjernen) including data-warehouse (Spring 2015). Enterprise model As-Is figure below illustrates the NTNU legacy integration system As-Is:

- **B - Business Architecture:**
Viewpoint business illustrates the main enterprise/business processes at NTNU supported by the legacy integration system (Kjernen).
- **C - Information Systems Architecture:**
Viewpoint application illustrates source systems flow to databases (Kjernen and data warehouse) and application services supporting enterprise/business processes.
- **D - Technology Architecture:**
Viewpoint infrastructure illustrates how data flow from source systems to Kjernen and infrastructure services.

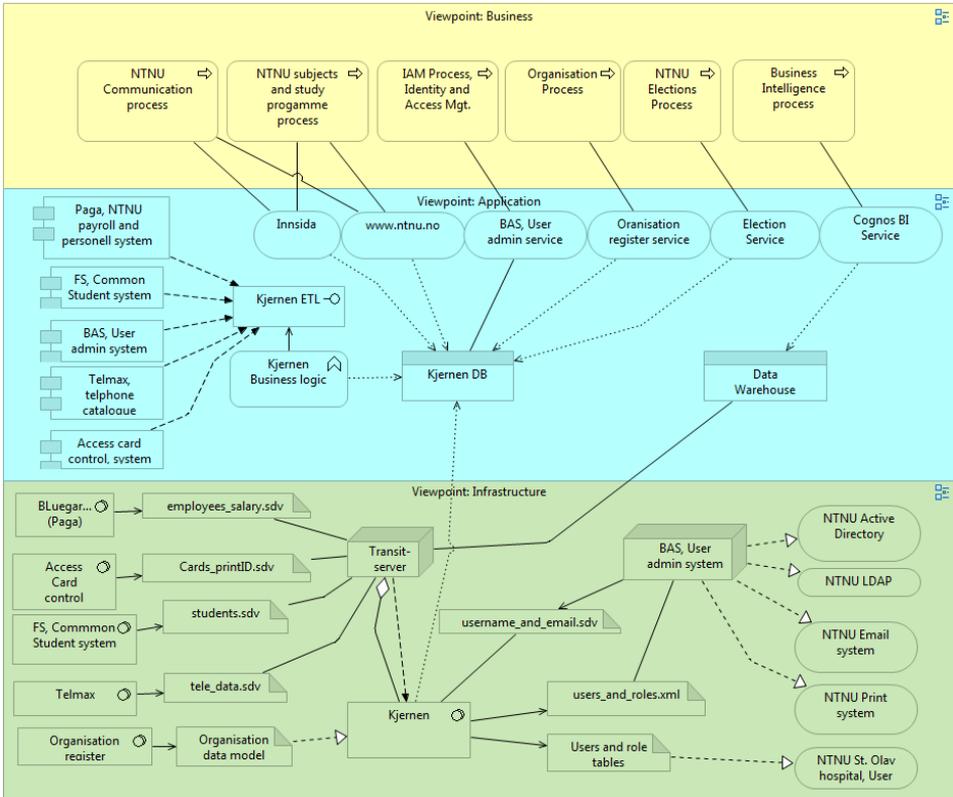


Figure 16.3: NTNU legacy system As-Is

16.20.2 TIA As-Is

This subsection describes TIA As-Is (Spring 2015). Enterprise model As-Is figure below illustrates the TIA system As-Is:

- **B - Business Architecture:**
Viewpoint business illustrates the main enterprise/business processes at NTNU supported by TIA.
- **C - Information Systems Architecture:**
Viewpoint application illustrates data flow from infrastructure to database (Neo4J) and application services supporting enterprise/business processes.
- **D - Technology Architecture:**
Viewpoint infrastructure illustrates how data flow from source systems to database (Neo4J).

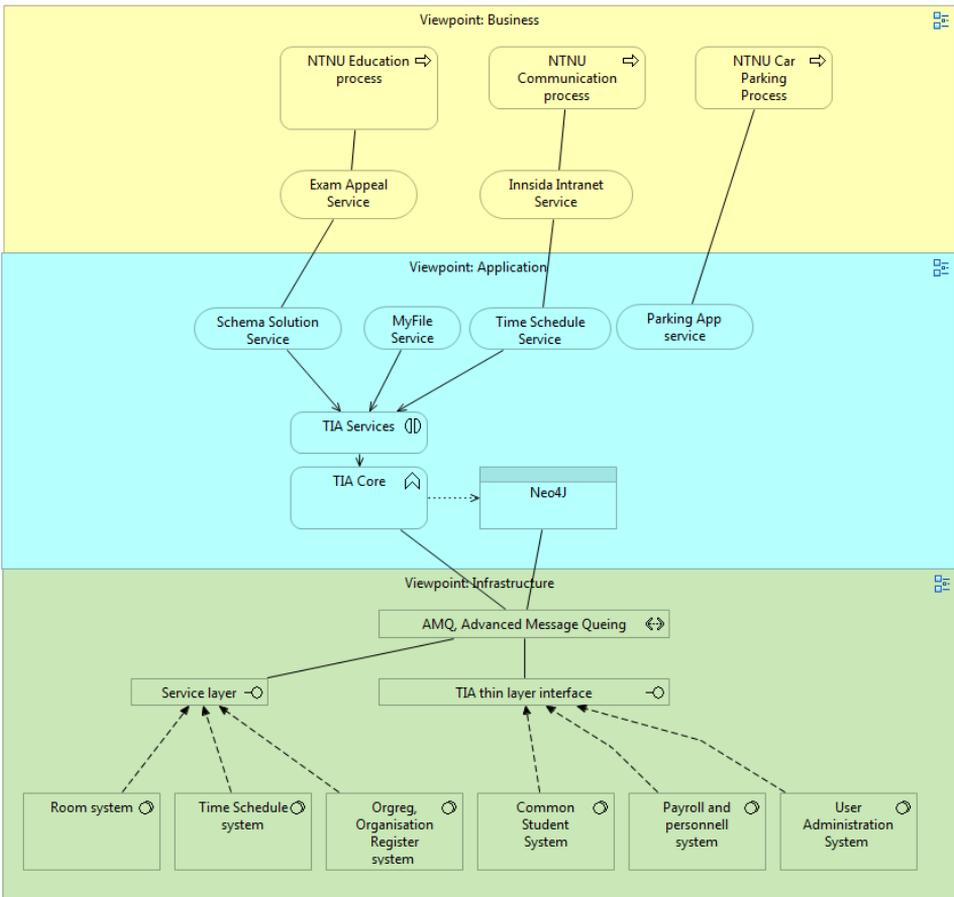


Figure 16.4: TIA As-Is

16.20.3 Preliminary Phase - Framework and principles

Describes the preparation and initiation activities required to create an Architecture Capability including customization of TOGAF and definition of Architecture Principles.

- Frameworks: Input, ITIL, Gartner Governance model and TOGAF.
- Input: DIFI (43) and TIA (7) architecture principles

Frameworks

- ITIL:
The NTNU IT operation processes are derived from the ITIL framework. This is described in chapter 5.5 and Appendix F.
- Gartner Governance model:
There is a IT-decision model implemented. "This is really a very lite governance model derived from Gartner. It does not yet have a complete scope. It is the project portfolio in the central administration." (50). Actual governance practice is a lite governance model and governance by the IT project and project folio (50).
- TOGAF: The IT-architects at NTNU IT-Division primarily apply a TOGAF (45) approach (Appendix F) for the architectural work. "IT-architecture work at NTNU in a TOGAF perspective is far from complete. Reason for this is that the IT-architect function is understaffed. The IT-architects use most of their resources on processing prospects from customers, stakeholders and supporting ongoing projects. Therefore architectural work as documenting and collecting the architecture and designing target pictures is not prioritized" (46).

DIFI and TIA architecture principles

NTNU is placed under DIFI's (43) architecture principles:

- Service orientation
- Interoperability
- Availability
- Security
- Openness
- Scalability

The TIA project (7) has defined following architecture principles:

- Source independence
- Data quality

-
- Data availability
 - Loose coupling
 - Data freshness
 - Service orientation
 - Robustness
 - Law-abidingness

16.20.4 A - Architecture Vision

Describes the initial phase of an architecture development cycle. It includes information about defining the scope of the architecture development initiative, identifying the stakeholders, creating the Architecture Vision, and obtaining approval to proceed with the architecture development.

- Architecture development initiative: Input, TIA project effect oriented goals (7), Assignment (2) and Problem description (1, p. 17).
- Architecture Vision: Input, ICT Target Picture document (42).
- Identifying stakeholders: Input, TIA Stakeholder Analysis (61).

Architecture development initiative

TIA project effect oriented goals (7):

1. Improved user experience by providing consistent IT services.
2. Simplify the cooperation internally (The NTNU IT Division) and externally plus simplify introduction of new services in the organization providing consistent IT services.
3. Strengthen IT support to research and education by change use of resources from basis IT to IT supporting research.
4. Achieve cost reductions and and improved environment profile by consolidating technical infrastructure.
5. Achieve an acceptable information security level.

Assignment (2) is described in chapter 1.1. And problem description is described in chapter 1.3.

Architecture Vision

The figure below displays a sketch of an Enterprise model at NTNU where ICT-services support the most important focus areas at NTNU: Research, education, innovation, and communication (41). The architecture is described in the document: ICT Target Picture for NTNU (42).

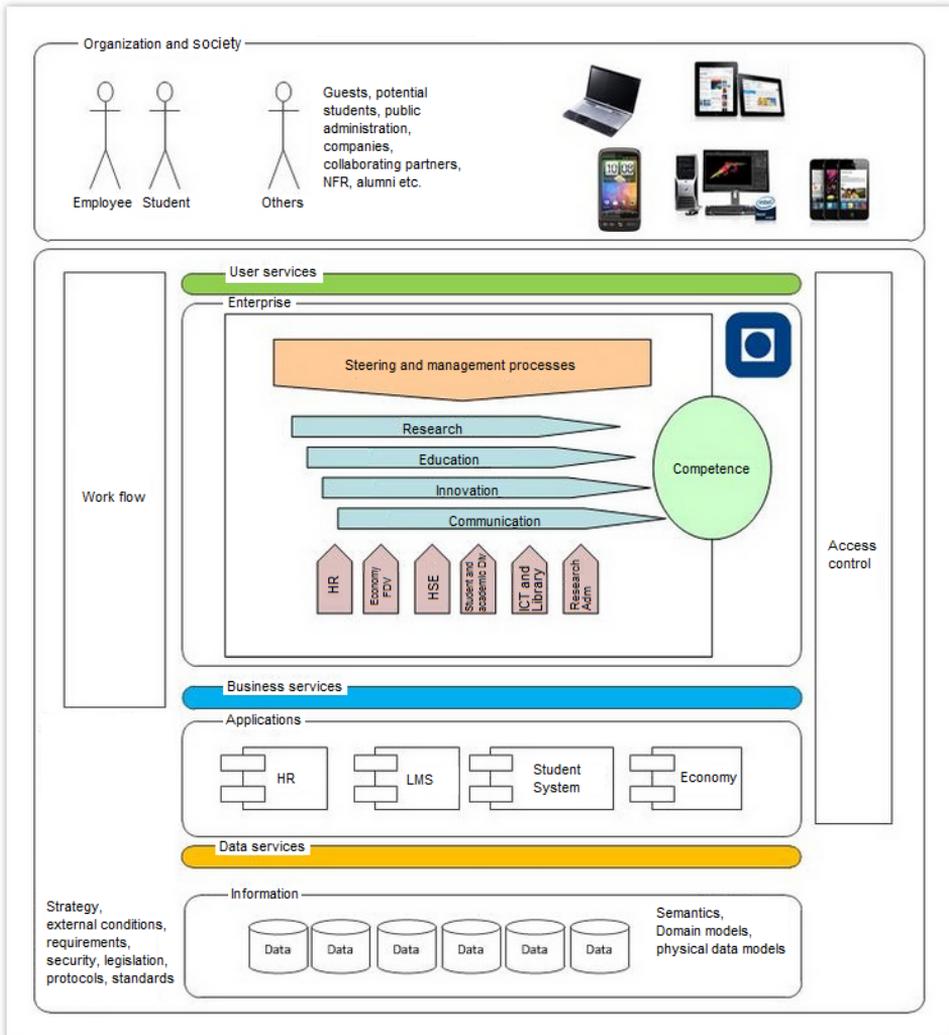


Figure 16.5: Sketch of NTNU Enterprise Model

Identifying stakeholders

Identify stakeholders as IS (61):

- Developer - TIA project
- User - Developer NTNU IT
- User - Developer NTNU Employee or student
- System owner
- Content owner
- User projects: New projects applying TIA technology.

16.20.5 B - Business Architecture

Describes the development of a Business Architecture to support the agreed Architecture Vision. (Appendix F) The objective is to define and describe the product and/or service strategy, and the organizational, functional, process, information, and geographic aspects of the business environment (18)

TIA Architecture in Business Context. Viewpoint business illustrates the main enterprise/business processes at NTNU supported by TIA.

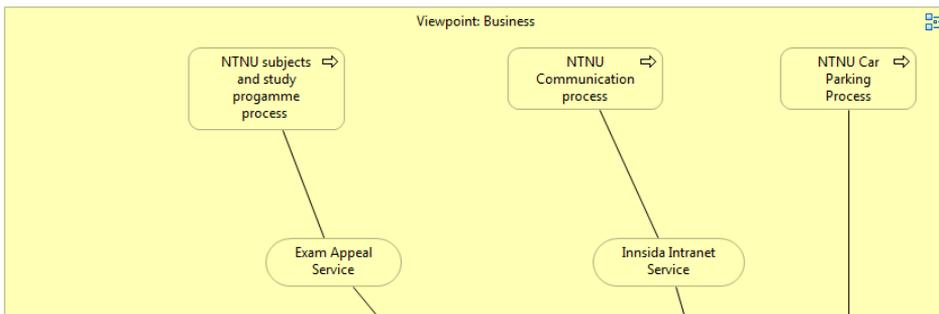


Figure 16.6: TIA Business Architecture As-Is

16.20.6 C - Information Systems Architecture

Application Architecture

iewpoint application illustrates data flow from infrastructure to database (Neo4J) and application services supporting enterprise/business processes.

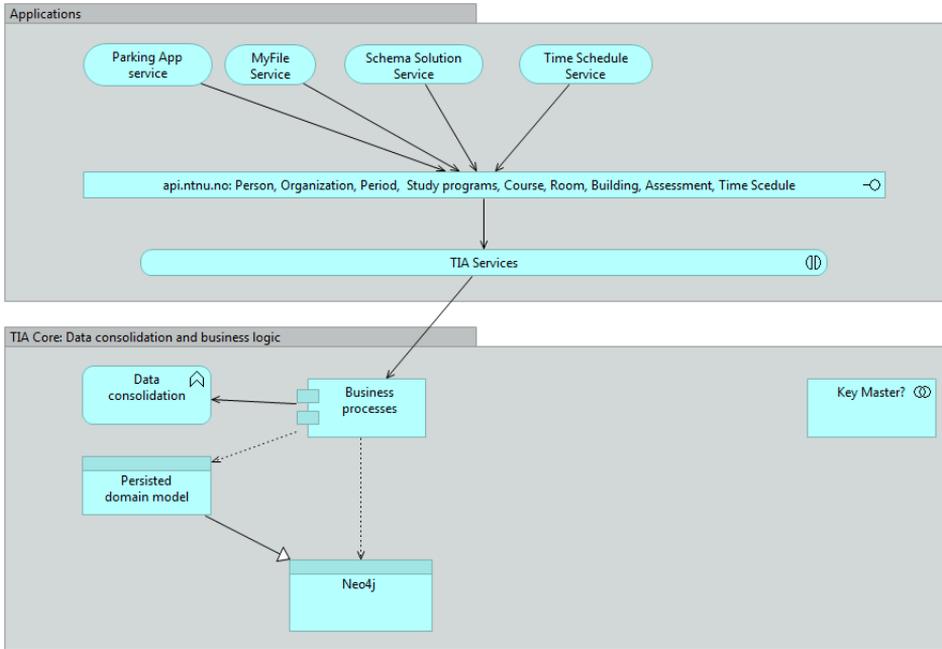


Figure 16.7: TIA Application Architecture As-Is

Detailed Application Architecture:
api.ntnu.no provide webservice interfaces for: Persons, organization, period, study programs, subjects, room, building, evaluation and time schedule.

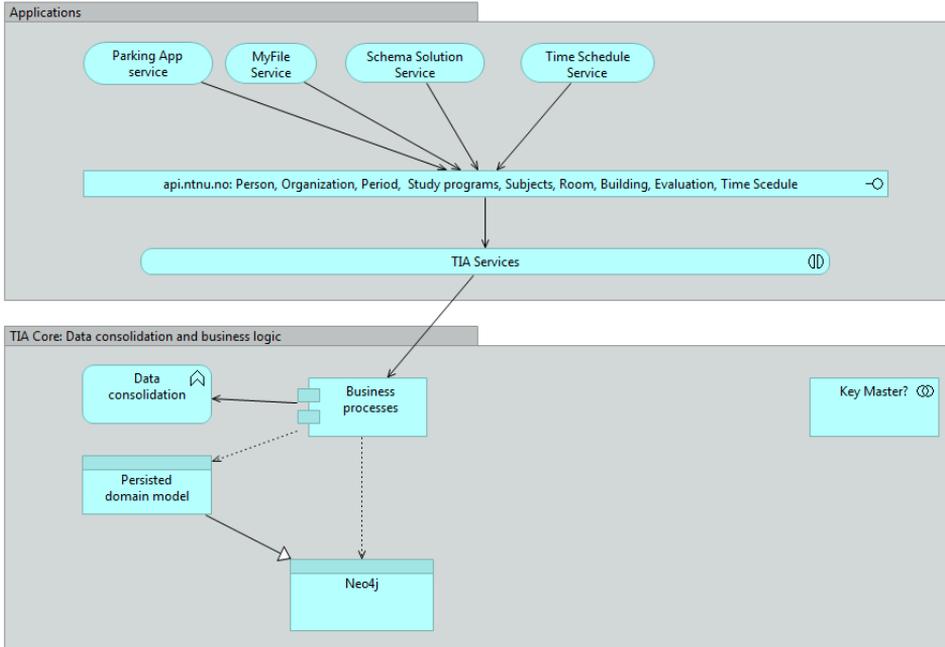


Figure 16.8: Detailed TIA Application Architecture As-Is

Information Architecture

TIA applies Neo4J as database. Neo4J is a graph database allowing a flexible data entity structure. See figure below:

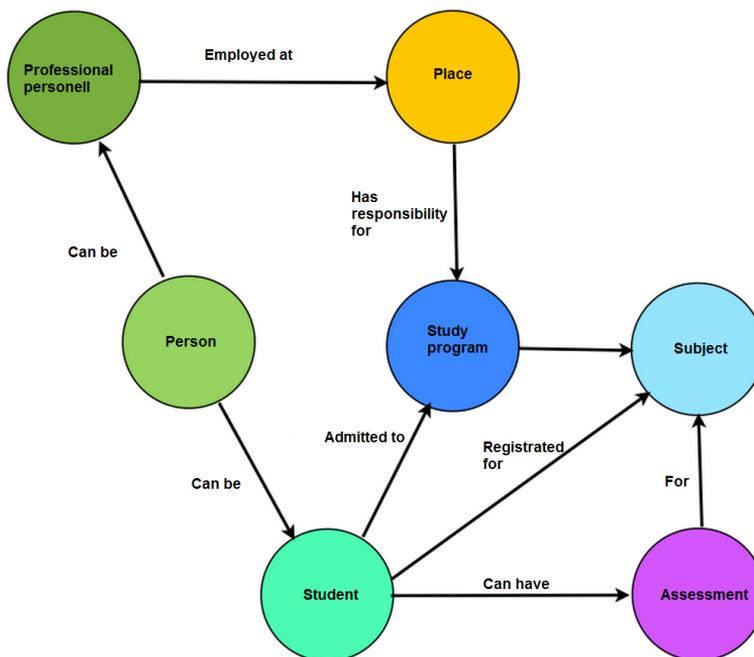


Figure 16.9: TIA Neo4J graph database entity structure

Information Model:

Information objects should be described as concepts and models in a standard manner. This description of information objects, concepts for individual things such as student and buildings, is usually called an Information Model (65). An information model of the most important information objects The information model is defined by Examination Regulations at the Norwegian University of Science and Technology (NTNU) (70).

- **Course** - The smallest unit in which the student can receive an assessment and course grade. The extent of the course is measured in credits. The course involves activities that form the basis for assessment. The activities may be compulsory.
- **Subject** - A collection of courses in one group in a program plan.
- **Program of study** - A group of courses that forms one academic entity that students can apply for admission to, receive the right to study, and leads to a degree.
- **Assessment** - The evaluations a student receives on the basis of his/her performance in a course, or a group of courses and that lead to a grade.

- **Final examination** - A type of assessment that normally follows at the end of the semester under conditions that can be controlled. The final examination generally is the concluding assessment of the student in a course or a group of courses.

These regulations refer to the Act relating to Universities and University Colleges of 1 April 2005, no. 15 (71).

16.20.7 D - Technology Architecture

Viewpoint infrastructure illustrates how data flow from source systems to database (Neo4J)

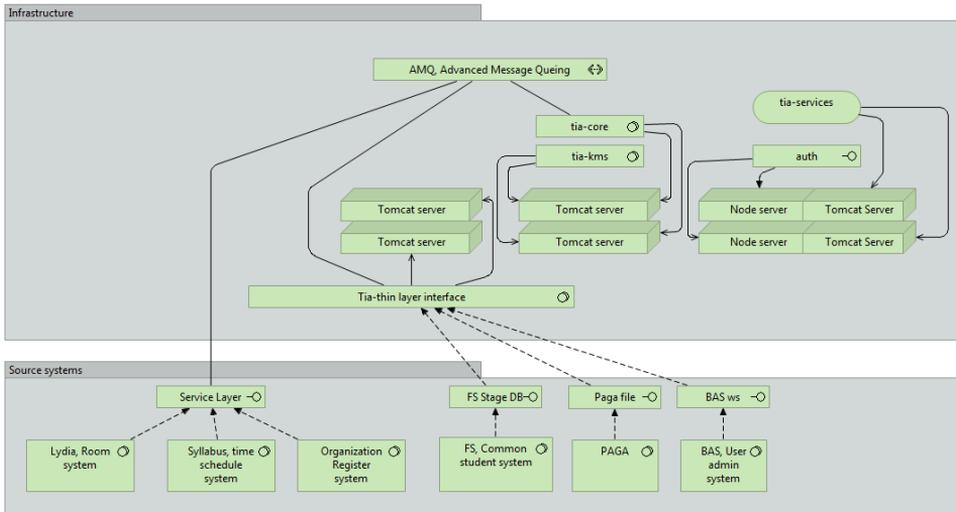


Figure 16.10: TIA Application Architecture As-Is

Appendix H

16.21 Conversations

This appendix list reports of conversations referenced in the thesis.

16.22 Conversation with Jostein Gunnes 17. June 2014

Role: Former Kjernen system responsible and project manager, NTNU IT Division (now retired).

Email: -

Today NTNU has an integrations system called Kjernen (The Core). It integrate and assemble NTNU data such as:

1. User id's and roles.
2. Organization id's describing roles.
3. Change of personal identification number.
4. Assembling id's from various source systems and linking it to personal id.

Management of integration and data flow has functioned in following way:

- The ITIL change process. The process has been followed in our own system (Kjernen). It has not been followed in the source systems.
- The NTNU IT Division has not been the position to be proactive regarding integrations and purchase/procurement of new (enterprise) systems.
- The chain of value: Customer, supplier and data/system owner is to large degree depended on personal relations.
- Projects are started with development phase and resources are then occupied with operations. There is a lack of planning of operations in advance. There is a lack of visualization of the requirements for operational resources. And there is a lack of understanding the complexity regarding management of integrations and data flow.

-
- Coordination meetings between persons with relevant domain knowledge. These persons have not always had the necessary mandate to take decisions. That is why anchoring of decisions often have been unclear. This might work out during development or project phase of a system. In the operations phase anchorage for decisions are dismantled when the project group is closed.
 - There is a lack of routines regarding orders of integrations. Small orders are done informal. There should be a divide between small and large orders.

Projects related to integration and data flow lack of general coordination. That again might lead to lacking overview and failure to communicate. There is a strong need for establishing processes that defines integration governance at NTNU.

At NTNU integration and data flow covers several business domains such as: Study Administration, Communication, Organization, Financial Administration, HR and Business intelligence. The Business Intelligence project has a clear focus and anchorage from the management at NTNU. This give a clear scope for the assignment.

Further comments:

- Teamwork is important!
- Interface agreement with data supplier. Referring to the Business Intelligence project.
- Recommend to consider the Method1 framework.

16.23 Conversation with Erlend Gutteberg 18. September 2014

Role: TIA developer, NTNU IT Division.

Email: erlend.gutteberg@ntnu.no

In September 2014 NTNU IT-Division launched an new NTNU parking app for Iphone and Android developed by an external supplier. TIA was applied as the integration platform. Developing integrations for the new parking app for Iphone and Android took less than 2 days. The new TIA integration platform has proved to be a large improvement compared with legacy integration platform.

16.24 Conversation with Noralf Husby 08. January 2015

Role: Strategic adviser, NTNU IT-Division/Kantega

Email: knut.n.husby@ntnu.no

1. It is OK to use NTNU architecture related documents in the master thesis. The documents are open.
2. Updated ICT document is sent (42).
3. Governance documents are not defined. However, there is an actual practice. The architects would have great use for target pictures for processing the most usual prospects related related to (42):
 - TIA/SOA
 - IAM
 - Data storage
 - Client equipment
 - Security
4. Governance related to integration/information?
General interoperability - DIFI principles - the consciousness is ok - It is matter of interpretation.
5. TOGAF knowledge base:
 - There is a lack of focus collecting links/documentation
 - The capacity for work in the architects group is to small. To few people to do all the work.
 - The architecture is not complete. Documents and links are not collected. This caused by lack of capacity. Architects are tied up in requests from customers and projects. There is not enough time to document the architecture and create target pictures for architecture.
6. Splitting architecture roles?
 - There should be an architecture role for general principles.
 - There should be an architecture role for projects.

16.25 Conversation with Hege Knotten 28. January 2015

Role: Former TIA project manager, NTNU IT Division.

Email: hege.knotten@ntnu.no

Table 16.57: TIA projects

Name	Period	Cost
1. TIA pre-project	2012-2013	4.0 mNOK
2. TIA project	2013-2014	3.6 mNOK
3. TIA II project	2014-2015	4.1 mNOK

TIA Total cost 11.7 mNOK

TIA was set i production December 2013. Following services has been released:

- MyFile service for NTNU: A service for presenting personal user information for students and employes at NTNU.
- Time schedule for NTNU. Providing an individual time schedule for all students at NTNU.
- Schema solution for NTNU. Providing e.g. a service for exam appeals.
- Parking solution for NTNU. Makes it possible for NTNU employees and student to use mobile parking App for Iphone and Android.

In January 2015 TIA was handed over to line organization.

A road map transforming legacy system Kjernen to TIA services was made 2014. Road map is a part of new project called: Improving Service Portfolio Efficiency. Planned start for this project is 1. March 2015.

Hege Knotten think it is important to focus on clean and good integrations. The scope of TIA project did not deal with Governance and decision models like Budget, who and what. These concerns are described in the TIA project end report. An example is who (which stakeholder) will pay for new integration initiatives. Knowing this fact does not encourage new initiatives and innovation. So the current budget model should be changed. With current situation it is "cheaper" to develop a non standard integration solution at a local faculty or department at NTNT. This because it is this work is covered by an employees "salary" anyway.

There should be a policy having TIA as first choice for integrations. To extend the lifetime for TIA there must be innovation and evolution. Else TIA will die. Governance activities should depend on a function like Center of Excellence and an extended service manager dealing with SLAs and contracts. The contracts should describe end to end responsibility concerning data ownership. These contracts can be attachments to SLAs.

16.26 Conversation with Jan Sverre Ronning 10. February 2015

Role: Adviser, NTNU Student and Academic Division

Email: jan.ronning@ntnu.no

16.26.1 Information Model

Description of information model in chapter 8.. is based on by following legislation and FS User Documentation:

- The Norwegian Act relating to universities and university colleges of 1 April 2005 No. 15. cite; <https://lovdata.no/dokument/NL/lov/2005-04-01-15>
- Act study regulations for Norwegian University of Science and Technology (NTNU) cite; <https://lovdata.no/dokument/SF/forskrift/2005-12-07-1684>
- FS user documentation: fellesstudentsystem.no

Authority is given by the Norwegian parliament regarding how NTNU should look like. Constraints: Requirements for Research and study programs. E.g. Size of a subject Act study regulations describe what a subject is. This is quoted at DBH website (www.dbh.no) and terms for what data is published.

16.26.2 FS

FS is a large Database and information system (About 800 tables) with relative large data-volumes. The main information in FS objects are: Person, Role(Derived), Organization Unit, Subject and Study Program. Most tables and function in FS are mainly support functions for the main information objects above.

16.26.3 FS and Data quality

Requirements for reporting is given by the Ministry of Education and Research. NTNU reports to DBH (Database for Higher Education). Based on reported NTNU results. Such as number of graduated students and publication points for research publication. NTNU and its respective departments receive funding from the Ministry of Education and Research. The reports sent from NTNU to DBH are based on FS. The main stakeholder for FS in the Ministry of Education and Research and require homogeneous and standardized reporting. Therefore NTNU it its departments funding depend on the data quality registered in FS. And the incentive for data quality in FS at most departments and study programs are very high. However there are issues regarding FS and DBH reporting for NTNU post education and international students.

Also there are issues regarding identities for foreign students. Foreign students often lack documentation of their identity.

16.26.4 Governance?

Jan Sverre Ronning has requested the IT-Division to have a forum where to coordinate issues regarding the integration of the information objects in FS.

16.26.5 Model testing

Model Testing 10. February 2015 (Appendix I): JSR Had several comments on the Information Model:

- The relations between the information objects are in reality more complex than initial the initial Information model (v0.1)
- The information model describing all contexts where the main information objects are consumed is meaningful but not entirely correct.

16.26.6 Questions:

- Does the relations the information model give meaning?
Answer: Yes
- Does the various contexts as IAM and BI/DBH reporting give meaning?
Answer: Yes
- Is OK to publish this conversation?
Answer: Yes

16.27 Conversation with Martin Fjeldvaer 17. February 2015

Role: Project Manager NTNU Intranet Innsida. NTNU Communication Division

Email: martin.fjeldvar@ntnu.no

16.27.1 Schema Service

The intention of the Schema Service is to support an automated and standard way to handle schemas at NTNU. There are all kinds of schema. Two typical examples are:

- Schema for Explanation of grades and appeals
- Schema for Phd. degree

The Schema service does not address schema that are included in other systems such as holiday leave (paga).

16.27.2 Schema situation As-Is

Different Schema and Schema technologies are used in various NTNU units. See figure below Many schema supports many processes:

1. There are many process owners
2. There is a lack of a forum and financing
3. There are types of schema services slipping through the cracks.

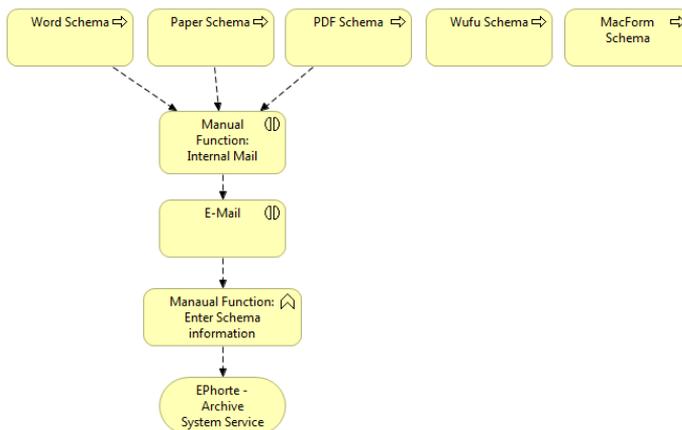


Figure 16.11: Schema situation today

There are many NTNU organizational units making their own schema solutions in their respective administrative systems and business silos. E.g. in the NTNU Communication

Division there are two schema tools: Wufu and Survey Monkey. Another example is the NTNU International Section using their own schema tool and administration system, as well as home made systems such as Btb schema (Internal orders).

16.27.3 Schema situation To-Be

NTNU Communication Department has implemented MacForm as a Proof Of Concept (POC). See figure below.

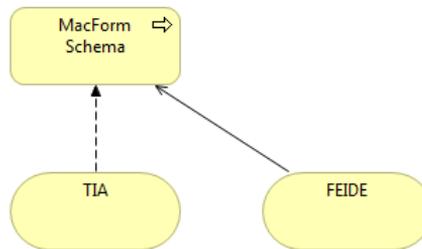


Figure 16.12: Schema situation To-Be

Want to have new Schema tool doing:

1. Authentication
2. Pre-fill of already known data/information from TIA such as:
 - Student number
 - Candidate number
 - Address
 - Name
 - Telephone number
 - E-Mail

The new Schema Service is performing both standardization and integration. Below is a model of the new TIA Schema Service.

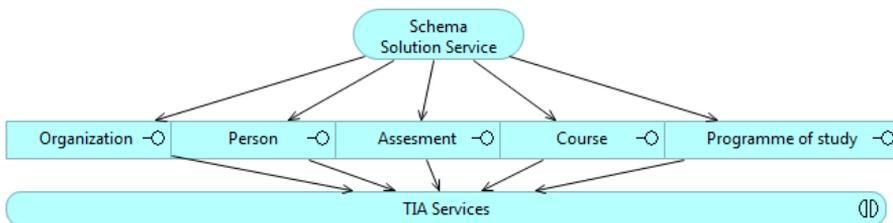


Figure 16.13: TIA Schema Service

Security issues current solution

Current solution has been set in production. This is a significant improvement compared with the manual solution in figure 15.3 above. Using Email as information carrier to Ephorte (Archive system) is not a secure solution. E-Mail is not regarded as a secure information carrier. SharePoint or TIA might be a secure information carrier in a future solution.

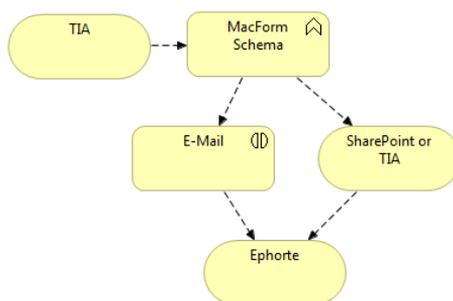


Figure 16.14: Schema Issues

Other comments from Martin Fjeldvaer: TIA is the most important project at NTNU.

16.28 Conversation with Hanne Iren Midttun 19. February 2015

Role: Project Manager: Efficient Service Structure

Email: hanne.midttun@ntnu.no

16.28.1 Project: Efficient Service Structure

Project target and description:

1. Target: Utilize TIA for improved IT-Operations and improved services for the customer. The vision for the project is: "Everything in and out via TIA"
2. The project is a part of the Basis-IT II programme. Hege Knotten is Programme Manager.
3. The project is partly based on a road-map made last year. The road-map is a plan to migrate from legacy technology (Kjernen) to TIA. It is not sufficient with a natural closure of systems.

16.28.2 Project priority list

Improving the Efficient Service Structure Project has following priority list:

1. Syllabus data (NTNU Time Schedule system). Remove from Service-Layer. Ongoing activity.
2. Entrance card control system project. Ongoing activity. Deadline 1. June.
3. Replace Service Layer. Ongoing activity. Effect: Release developer resources and improved cooperation against the NTNU Communication Division.
4. Cristin is an important system (Research reporting system). The data stream is stable. Christin has no interest of changing in changing to TIA. TIA is delivering authorization data.
5. FS is important. FS IT-Operations is planned outsourced USIT/UIO. This will cause changes of interfaces between TIA and FS.
6. Important to show results. Want TIA to be a success.
7. BAS (User Administration System). Easy cooperation. Requires more data.

16.28.3 Risks

Following risk are for the project identified:

1. Changing integration for the Cristin system have a large risk. This because of many stakeholders.
2. The FS integration in connection with outsourcing is a large risk. There are several interfaces in current integration solution. It is unclear how these interfaces will be implemented when outsourced.
3. Least risk is BAS.

16.28.4 Governance related to TIA

Governance is not related to technology (TIA). Following governance issues where identified:

1. There is not made documentation for procurement, architecture, security and integration.
 - This related to how projects shall do integrations.
 - Projects must start at scratch every time.
 - At which fields can project managers cooperate regarding methodology and documentation. This is individual dependent.
2. E.g. We get a system already purchased by the NTNU organization. NTNU-IT is included late in the purchase/procurement process. Important decisions are already taken. This leads to Ad-Hoc solutions in which lead to poor documentation. This again lead to poor transition to IT-Operations.
3. Who to make which decisions are not clearly defined. Decisions are made at all levels. Procurement/purchase is regulated by legislation. Consultant services are invited to tender.
4. Ownership of data is clearly defined. NTNU own the data. But we need help from domain experts to use the data. NTNU IT has misused data not coordinating with domain experts.
5. Security issues:
 - What is public and not public data? This is uncertain or unclarified.
 - E.g. flag for leave of absence. Where can this be published?
 - What is defined as sensitive or not sensitive data? There is no categorization of sensitive data. This depends on context:
 - HR: Medical certificate
 - Employees: Exposure
 - BAS: Passwords
 - And indication of quality of information is also lacking. E.g. Mobile number and two-phase authentication.

-
6. DMF (Faculty of Medicine NTNU) and USU (Extended Service Extraction) USU have several clients: E.g. Innsida and DMF. A change in the service relation table will affect several systems. This is a software issue.
 7. We have no customer relations regarding TIA.
 8. We lack tracking of orders for integration and data deliveries. And there is a lack of consequence review related to orders.

16.29 Conversation with Hege Knotten 27. February 2015

Role: Basis IT 2 program manager.

Email: hege.knotten@ntnu.no

16.29.1 TIA risks:

1. Authorization is the largest risk. Is is a potential show stopper for making TIA efficient. Have been waiting for the IAM project.
 - Now authorization rules are being hard coded. This is very ugly. (Hanne is on the case)
2. What are authoritative sources for what? For TIA write-back to sources this will be complicated. TIA is robust in finding which data from which data sources. However this is complicated for write-back when there are several data sources. Several authoritative data sources for the same data is complicating write-back. Ideally one data element should have one source only.
3. Anchoring for using TIA as data/source-supplier for NTNU is now improved.
4. There is not enough resources to "get in line"
5. Not implementing a center of excellence is a huge risk:
 - No governance function
 - No life cycle management
 - A possible improvement loop is disappearing. Why where things made as they are? And what is the potential for improvement in the start of the IT-operations phase?
 - The choices made must be reasoned and based on a strategy!
6. Ignoring design the principle low coupling and high cohesion is risky in TIA context.

16.29.2 TIA opportunities:

1. From Kjernen to TIA. Person related data from all sources such as: Student, employee and all organization places having a courses.
2. Couple data across the NTNU organization: Room, studies and student mass roles. E.g. a student purchasing relevant literature at the Academica book store. Because you are a student the required reading list can be automatically generated. on demand.
3. The update frequency of information is not dependent on nightly batch job.
4. Stability: Upgrading nodes can be done without downtime. This because of node redundancy.

-
5. Time to market. To take in new data sources has shorter implementation time.
 6. Reduced dependency on suppliers. This because of the TIA thin layer. More plug and play functionality.
 7. For the consumer active use of TIA will give the same data result each time.
 8. Opportunities related to TIA and the NTNU program: "IT in Education":
 - Before i.e. the LMS, IT's Learning had its own FS-data set.
 - Now: One data element only have to exist one place.
 - A new LMS do not need to transfer and store data.
 - Easier to remove LMS. Modularization.
 9. Avoiding double storage of data. Data is accessed through query only. This removes complexity in data middle storage and data middle naming.
 10. In principle there is only one data element. Then the data ownership is clearer.
 11. Removal of complexity. Spreading of data to all consumers. No direct dependency between supplier, service and consumer.
 12. E.g. Calendar service. Only one source meaning standardization.
 13. E.g. Mazemap (A simple tool for indoor navigation: Mazemap.com). All data can be moved to one source.
 14. Easier to avoid vendor locking. This by setting requirements for standard interfaces against suppliers. Standardized interfaces makes it possible to have a plug and play philosophy.

16.29.3 Cost benefit analysis:

1. No, this has not been done so far in TIA context.
2. Cost benefit analysis should be done as a part of governance.
3. Have not found any cost benefit analysis of a SOA implementation. Only one project could say it had a cost benefit. It is difficult to visualize the effects of a SOA implementation on the bottom line. The effects are more soft values as security, stability and time to market. The effects on a SOA implementation is not measured as profit and loss. It takes many years before you get return on investment (ROI).

16.29.4 Projects relevant for FS and TIA:

1. Easier availability for which students taking which courses.
2. E.g. Take one large course as Ex. Phil. There are many students. Student groups are divided after the time lecture are held, then divided into work group locations. Source data is lacking in FS.
3. Progression of studies related to which students can hire a place to live by SIT.

16.29.5 TIA standardization and security:

- TIA have the same security model for all data.
- Authorization model must mirror all permits given by data or system owner.
- In the TIA security model changes can only be done in one module. This is not yet implemented.

16.30 Conversation with Jan Sverre Ronning 10. March 2015

Role: Adviser FS system management, NTNU Student and Academic Division.

Email: jan.ronning@ntnu.no

16.30.1 Information Security and FS

1. Information regarding NTNU exams in public information
2. Only the personal identification code and some bank related data, such as account number, can be classified as internal information (blue) ref: Principles for Information Security at NTNU (77).
3. If personal addresses for a student shall not be available, there is a policy for not entering in the address in FS.
4. Other security aspects for FS: For database administration only employees (not students) shall have access to the FS database.

16.31 Conversation with Erlend Gutteberg 27. March 2015

Role: TIA Developer, NTNU IT-Division.

Email: erlend.gutteberg@ntnu.no

16.31.1 Information Security and TIA

There are no security requirements. What to deliver? TIA Security Principles (78) are defined, however they are not updated and not complete. As a guideline all data should be open. And there is an established TIA Information Security Practice:

1. General principle: "Beware poster" Nb! It is undefined.
2. As a starting point everything is closed: Authentication. E.g. for authentication username, URL and HTTP-method name is required. (Basic Auth over https)
3. Everyone having a NTNU user affiliation can access data except personalized data. E.g. Access to subjects and time schedule data, but not access to subject teacher data. This because it is personalized information.
4. Everyone has access to their own personalized information.
5. Some system administrators has full access. E.g. the Key Card System has access to all person information. (In practice there are three authentication levels: Open, personal and full access)
6. Exceptions must be tailored. E.g. for the parking App only data data set required is made available.

-
7. Possible rule: Authorization should be based on TIA data. But the rules should be handled outside TIA (Separation of concerns). E.g. Can use spreads from User Administration System (BAS). However, there is no active security policy for TIA.

Appendix I

16.32 Model Development and Testing

This Appendix document model development and test process for enterprise model and architecture To-Be.

16.32.1 Test criteria

1. Q1: Does the model provide a perception of how source systems, services and business processes are connected?
2. Q2: Does the model provide an overview?
3. Q3: Does the model provide a perception of who is responsible for which service?
4. Q4: Does the model provide a perception of who is responsible making decisions regarding a service?
5. Q5: Does the model provide a perception of who is responsible for giving input to decisions regarding a service?

16.32.2 Information Model Testing 10. February 2015, Jan Sverre Ronning

Role Jan Sverre Rnning: Adviser FS system management, NTNU Student and Academic Division. Email:jan.ronning@ntnu.no

Purpose: Test and development of model

Note the test criteria above was not developed at time this test where conducted.

JSR Had several comments on the Information Model v01 (See figur below):

- The relations between the information objects are in reality more complex than initial the initial Information model (v0.1)
- There is no direct relation between information object Person and Study Program.
- There is no direct relation between information object Person and Org Unit.
- The information model describing all contexts where the main information objects are consumed is meaningful but not entirely correct.

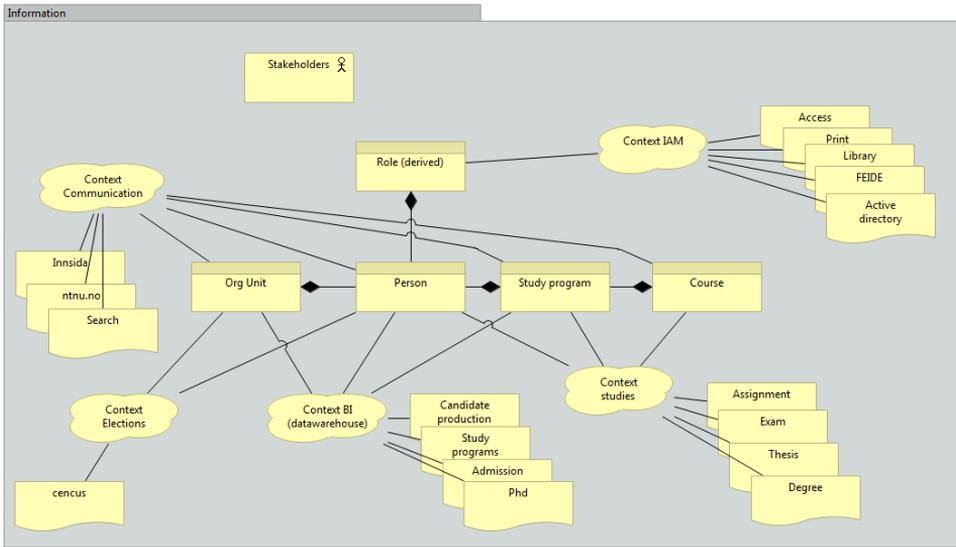


Figure 16.15: Information Model v01

After corrections from JSR the model was Corrected and divided to two models: Information Model v02a and Information Model v02a.

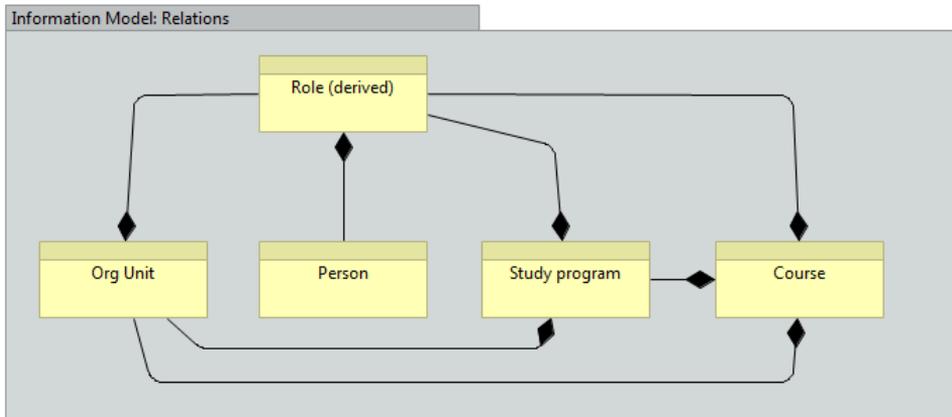


Figure 16.16: Information Model v02a

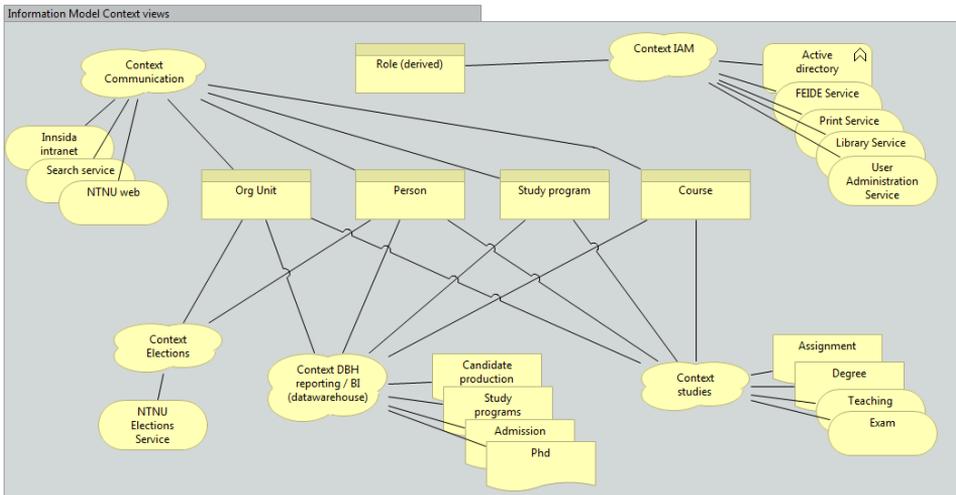


Figure 16.17: Information Model v02a

16.32.3 Enterprise model testing 05. March 2015, Erlend Gutteberg

Role Erlend Gutteberg: System developer (TIA), NTNU IT-Division.

Email: erlend.gutteberg@ntnu.no

Purpose: Test and development of model

Testing of model: TIA To-Be v01

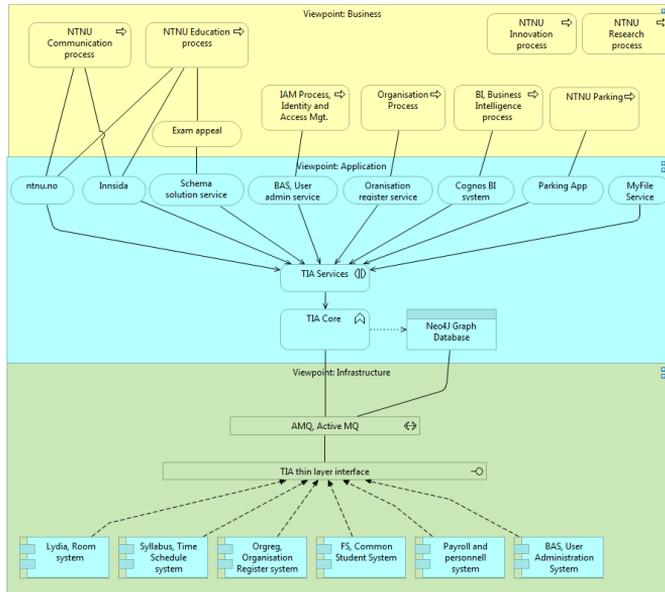


Figure 16.18: TIA To-Be v01

Q1:

- The business processes consist of several services. E.g. the Organization Service is used by IAM and mailing-lists for distribution and many other services. Use of data depends on the context.

- The complexity in the Organization Register (OrgReg) has caused a mix of data meant for different contexts such as: Economy, administration and education. Both Paga and FS are sources for OrgReg. TIA is dragging in more pure contexts as such Economy, administration and education. Then you can join the contexts.

Q2:

Yes, it divides in contexts.

Q3:

Yes, however the model must be refined displaying business services and their relation to business processes. Also the application services relations to business services must be refined.

Q4:

- No, this is unclear. Who are the owners? We in TIA must be able to say no to requests given there are some guidelines. E.g. if You do some changes in the parking app, it might cause changes in Innsida. This also inflicts the funding model. If a change in the Parking App inflicts Innsida and the Parking business service owner is paying for the change. Who should really pay for the investment?

- Distribution key. E.g. in the private sector the part paying the largest amount is given the largest distribution key. A another question arising is who should decide the distribution key. Why should the first mover pay for the entire investment? E.g. the new Student Card solution. Other stakeholders will benefit from that investment as well. NB! Reuse of services and data in other projects is a good thing.

Q5:

Yes, if the model visualize the owners..

TIA To-Be v02

After the test and evaluation of TIA To-Be v01, the model was modified and improved based on the question above. See figures below.

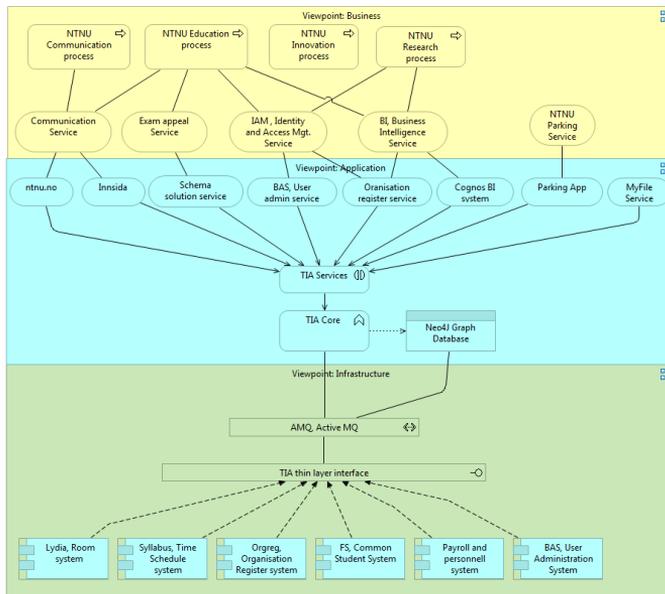


Figure 16.19: TIA To-Be v02

Business view with Stakeholders and Owners..

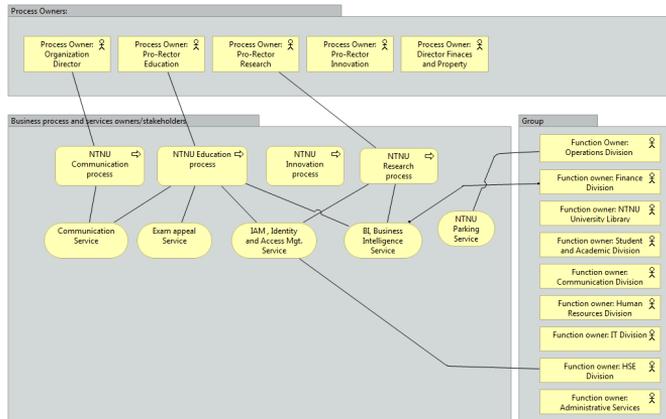


Figure 16.20: Business view with Stakeholders and Owners

16.32.4 Enterprise model testing 10. March 2015, Erlend Gutteberg

Role Erlend Gutteberg: System developer (TIA), NTNU IT-Division.

Email: erlend.gutteberg@ntnu.no

Purpose: Test and development of model

Testing of model: TIA To-Be v02

Q1:

Yes

Q2:

The model does not show ownership to data! Regarding data ownership the green layer (technology) give little value. The data ownership is disappearing in the TIA translation. The model in perhaps to complex. Simplify: Sky- ζ TIA - ζ Data. At refined level (technology and application) data and perhaps system ownership can be displayed.

Q3:

- a. Yes, for the Process Owner and Function Owner View.
- b. Difficult to distinguish between Process Owner and Function Owner.
- c. The understanding of concepts are ambiguous.

Q4:

- a. Yes, but it is difficult to perceive directions of the arrows.
- b. View: Business View Business Process and Business Services.

Q5:

Yes, All arrows going in and out to the service. Governance model: Must explain concepts. And make an example for how the decision process might be. E.g. development/procurement process of a new solution.

16.32.5 Enterprise model testing 10. March 2015, Jan Sverre Rnning

Role Jan Sverre Rnning: Adviser FS system management, NTNU Student and Academic Division.

Email: jan.ronning@ntnu.no

Purpose: Test and development of model

Testing of model: TIA To-Be v02

Q1:

- a. Exam Appeal Business Service and the Parking Business Service are too explicit. They should be a part of more general business services.
- b. There are lacking relations from the Study and Academic Division to all services.

Q2:

- a. Difficult to distinguish between a service and a function.
- b. The model should distinguish between the core NTNU processes and the support processes.
- c. Refining of core processes as Education is missing: E.g. Admission, teaching and exam.
- d. There is a mix of service and system

Q3:

- a. No, the relationship is not clear. Data-ownership is at least as important as Ownership of services. E.g. IAM and Cognos. IAM can not decide what is correct to present. That decision must be taken by data owner. To see examples for data ownership and data packages use DBH statistics for economy, student, areal and publications
- b. About Governance Model: The concepts are difficult to understand, but I understand the point of the model..

Q4:

Yes, but it is difficult to perceive the direction of the arrows.

Q5:

- a. Yes, but the model give more meaning regarding stakeholders than for process owners.
- b. The order

_____ NB! Comment for discussion: When evaluation/testing the model To-Be the testers are in NTNU context. It seems to a bit difficult for the testers to have in mind a To-Be model based on best practice..

TIA To-Be v03

After the test and evaluation of TIA To-Be v02, the model was modified and improved based on the question above. See figures below.

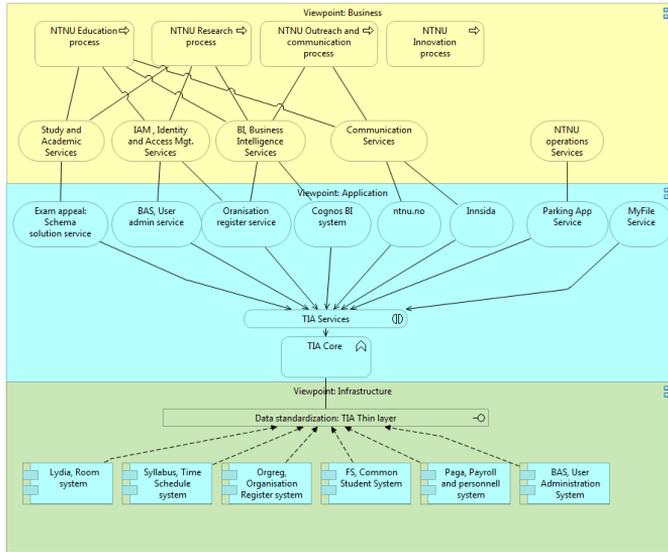


Figure 16.21: TIA To-Be v03

View: Data Flow Owner Complexity:

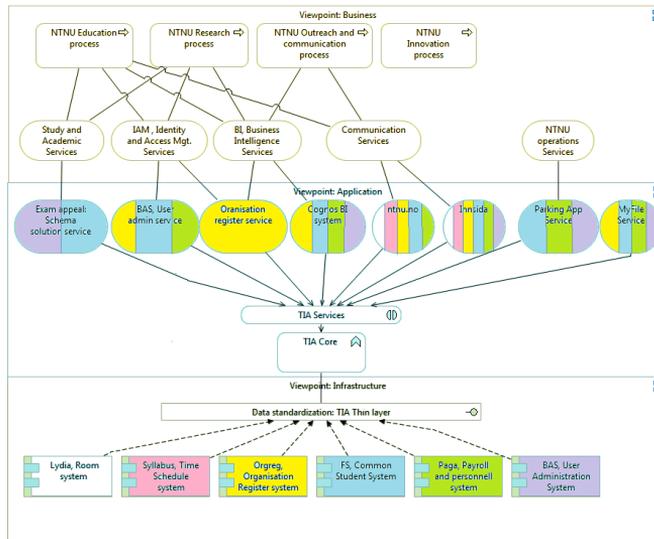


Figure 16.22: Data Flow Owner Complexity

Business view with Process, Function and data Owners:

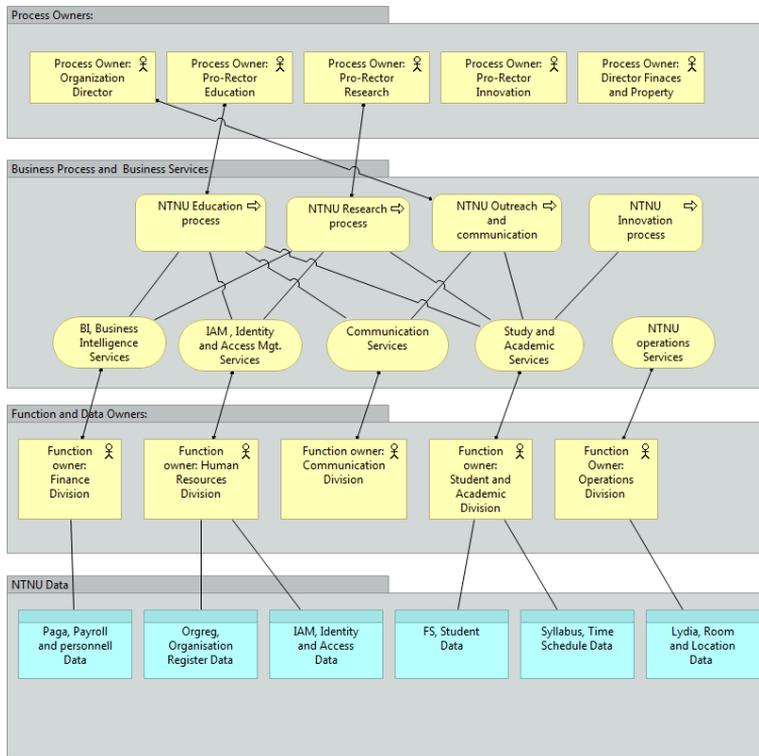


Figure 16.23: Business View Process and Function Owners v03

16.32.6 Enterprise model testing 13. March 2015, Per Atle Eliassen

Per Atle Eliassen: Senior adviser and IT-Architect, NTNU IT Division.

Email: per.atle.eliassen@ntnu.no

Purpose: Test and development

Testing of model: TIA To-Be v03 and engagement model To-Be (figure 9.12).

Q1:

It say something about how things are coupled. But it does not say anything about which data source elements supporting the a core enterprise process i.e. the Innovation process. However, the figure Data Flow Owner Complexity is a good representation.

Q2:

Yes, absolutely

Q3:

Yes, figure should be anchored. Especially the figure "Process, function and data owners view". Want to use that figure in our modeling work.

Q4:

Yes, but the IT-perspective is lacking. IT-for-IT. It is a good model, but the model (Process, function and data owners view) should be described with text for each level.

Q5:

No, not the "Process, function and data owners view" However, the engagement model To-Be below (same as figure 9.12) is very helpful. NB! It would be very interesting exercise to create an engagement model As-Is for NTNU.

	IT Principles		IT Infrastructure		IT Architecture		Business Applications*		IT prioritization and Investment	
	Input	Decision	Input	Decision	Input	Decision	Input	Decision	Input	Decision
Business Monarchy		V								V
IT Monarchy			V		V					
Feudal							V			
Federal	V			V		V	V	V	V	
Duopoly			V				V			
Anarchy			V							

Figure 16.24: Proposed NTNU IT-Governance engagement model

16.32.7 Enterprise model testing 18. March 2015, Torgeir Sesseng

Torgeir Sesseng: Adviser, NTNU Financial Division.

Email: torgeir.sesseng@ntnu.no

Purpose: Test and development of model

Testing of model: TIA To-Be v03 and engagement model To-Be (figure 9.12).

Q1:

Yes, know the picture and data sources: FS, Paga and Organization Register.

Q2:

Yes, however a short textual description is missing.

Q3:

Yes, TIA To-Be model does. TIA As-Is does not.

Q4:

Partly. Rector must be added. And responsibility for the Financial Director must be defined. Also financial data source as Oracle Financial should be added.

Q5:

Yes. In real life there is a connection between all business services and processes. (Business process, function and data owners View)

Business View Process and Function Owners v04

After the test and evaluation of Business View Process and Function Owners v03, the model was modified and improved based on the question above. See figure below.

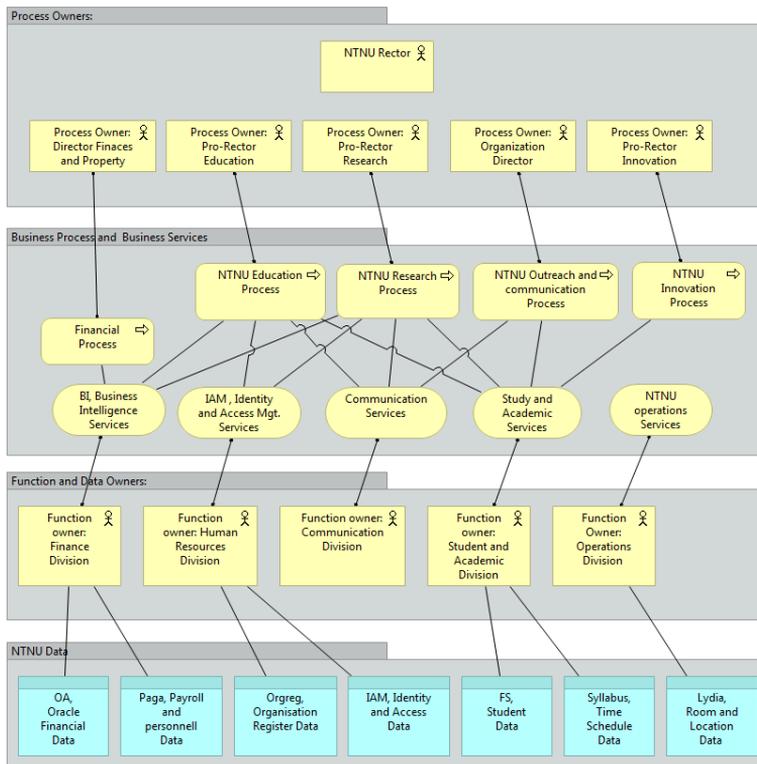


Figure 16.25: Business View Process and Function Owners v04

Appendix J

16.33 Model evaluation

Quantitative model evaluation is conducted by interviews. See model evaluation interviews below. The questions below are based on the purpose of the model described in chapter 1.3. The main purpose of the Integration Governance model is to govern how decisions are made among stakeholders concerning integration at NTNU. The best practice Integration Governance Model (figure 9.1) based on foundation of execution is referred to as the model. Does the model Govern how decisions are done regarding:

- Q1: IT-operations? To what degree? (1 - 5)
- Q2: Orders (Delivery of integrations to new projects or systems)? To what degree? (1 - 5)
- Q3: Change in source system, interfaces or target system (Change in applications)? To what degree? (1 - 5)
- Q4: Change of requirements by system owner or end user (Meaning change in work processes)? To what degree? (1 - 5)
- Q5: Security and categorization of information? To what degree? (1 - 5)
- Q6: Information and context (Data and information and have different meaning depending on context)? To what degree? (1 - 5)

Control questions:

- Q7: Does the model provide a target picture for governance of integrations processes (model). To what degree? (1 - 5)
- Q8: Does the model fit to NTNU? To what degree? (1 - 5)

16.33.1 Model Evaluation 13. and 23. April 2015, Developer at NTNU

Role: System developer, NTNU
Status: Quotation check conducted

Question no.	Score	Comment
Q1	5	
Q2	4	The model does not divide between projects and systems.
Q3	4	Referring to figure 9.8. Ideally integrations should contain source information and ownership. It can follow the integration as meta data.
Q4	4	The question is a bit unclear. Uncertain if question is about system owner of process owner. Do not need to relate to system owner, but process owner.
Q5	2	See improvement: Goal, Business Function and role below..
Q6	4	
Q7	4	Know about basis for governance. Should be more measurable measuring points.
Q8	4	Referring to figure 10.1. The "Unification" corner fit for administration. Standardization is positive for administration and production. While standardization becomes a constraint for research, development and innovation and fit the into the "Coordination" corner of the model. Can be divided into different "corners" the model depending on the the type of enterprise process. E.g for the FS system. The score would be 5. Regarding the NTNU merge there is a high degree of integration vi FS. A merge will direct against the upper right corner "unification" in the model. While the core enterprise areas as research and education will be in the upper left corner "coordination" of the model. The last based on a autonomous culture at faculties.

Table 16.58: Score Model Evaluation 1

Q5: Requirements for security and categorization of information did get a low score.

A model for security and categorization of information is created below. Archi notation is applied. Nb! Who is responsible for making decisions?

- Goal: Safety
 - Business Function: Classification of information
 - * Business Role:: Data owner, knows the context of the data.
 - Business Actor: Student and Academic Division
 - * Business Role: Security responsible
 - Business Actor: IT Security Manager
 - Business Function: Classification from several data sources combined
 - * Business Role: Security responsible

-
- Business Function: Ask questions about security
 - * Business Role: Subject, the person that the data describes
 - Business Actor: Student or employee
 - * Business Role: Data owner/data provider
 - Business Actor: Student and Academic Division
 - * Business Role: Data consumer, responsible for following the data classification, access or not access.
 - Business Actor: Developer
 - Business Function: Acceptance test for security
 - * Business Role: Data owner
 - Business Actor: Student and Academic Division
 - * Business Function: Place security requirements
 - Business Role: Security responsible
 - Business Actor: IT Security Manager

16.33.2 Model Evaluation 17. April 2015, Section manager at NTNU

Role: Section manager, NTNU

Status: Quotation check conducted

Question no.	Score	Comment
Q1	4	In place: responsible person, standardization and architecture
Q2	4	
Q3	4	
Q4	3	A end user or system owner will have a small impact on the model
Q5	3	
Q6	3	
Q7	3	It is a start. I must work on the issues I can influence and make an impact at my level
Q8	2	The degree of standardization of business processes I can not govern at my level. However I can Influence the degree of integration. NTNU fit in the Coordination operation model referring to figure 10.1. E.g. I cannot standardize the HR process and I am not sure if the Rector can do it either

Table 16.59: Score Model Evaluation 2

16.33.3 Model Evaluation 20. April 2015, Organization Director at NTNU

Role: Organization director, NTNU

Status: Quotation check conducted

Question no.	Score	Comment
Q1	NA	
Q2	NA	
Q3	NA	
Q4	NA	
Q5	NA	
Q6	NA	
Q7	Can't answer	
Q8	Can't answer	The model is an interesting input to a discussion. What decisions are decided where, by who and where? It seems like model tidy up in the decision structure. It is interesting that the model tidy up in various levels of decisions and degree of effect. Approach: What is the core tasks for research and education? NTNU has many systems with a variation in degree of integration and standardization.

Table 16.60: Score Model Evaluation 3

16.33.4 Model Evaluation 21. April 2015, Security Manager at NTNU

Role: Security Manager at NTNU
Status: Quotation check conducted

Question no.	Score	Comment
Q1	3	
Q2	4	
Q3	3	Changes are done by team and project participants and not architects. Vision, why and what is not an issue.
Q4	4	Each system supporting main processes education, research and support processes are build as silos. See figure NTNU Silos below. Important question? What is build with the intention to support what?
Q5	1	It is not a prepared working system. There is not an appointed system owner providing clear requirements and guidance about security. There are principles for security, however they are not operationalized and followed up by management.
Q6	4	
Q7	3	Not alone. It is a good basis for steering and governance. However, not for operations. For operations the model is to simple.
Q8	4	Yes, some things are a bit unclear. The model is clear at the decision level. And clear about who making decisions in any connection.

Table 16.61: Score Model Evaluation 4

Further comments:

- Anarchy archetype is often related to local IT supporting research and should not be standardized. E.g:
 - * Lab experiments
 - * Cybernetic simulations
 - * Design
 - * Processing - geo data
- Information sources for persons as FS and Paga can be integrated if it is related to conducting the employers responsibility. This referring to Privacy Act. Conditions: Restricted information is not compromised.
- The Person Registration Act has terms for processing of person information. There are requirements for accessing personal information, both static and dynamic information. Some of it is solved by be TIA My Map function. On the other hand IP address is also regarded as personal information and is not handled.

-
- In general terms, the system owner is responsible for classification.
 - Classification of systems by level confidentiality are not executed. It should be done by the system owners. Risk analysis and measures reducing risks are also missing.
 - In general, there are principles for classification of information: The highest classification of information in a system is the basis.
 - NTNU decision: PAM is the official NTNU project method for IT-related projects.
 - At NTNU there is a lack of a organizational related project method.
 - In general, at NTNU, there is not a concept for evaluating business cases
 - Risk assessment: Project managers have focus on the risk assessment regarding implementation of the project not the product or end solution supporting the business or enterprise.
 - You can have a risk. But it must be a conscious decision related to the consequence of high risk. This risk must be communicated and the manager must decide if the high risk is acceptable.

The model is weak at security. How to improve security?

- Goal: Classification
 - * Open
 - * Internal
 - * Confidential
 - * Strictly confidential
- Task: Training
- Task: Reasoning, why? Consequence and risk
- Task: Management focus and attention
- Task: Create requirements specification:
Security requirements, functional and non-functional requirements.
- Role: Employee:
Must have tools dedicated for information processing at classified level.
- Role: System owner:
Realize security requirements measurements reducing risk
- Role: Manager:

- * Economy: Expensive to process classified information. A wish to follow law.
- * Expensive to build systems satisfying classification requirements. Time consuming.
- Role: Training responsible:
Predict law! What you can do and not do..
- Role: KD (Ministry of Education)
- Role: Rector: Relevant tools at disposal.
- Role: Line manager

Education process	Research process	Process support					
Studies	Reserach	HR	wage system,	HMS	Personal IT	collaboration	
LMS	Cristin Bibsys	Paga	Paga		Client	Calendar Mail Lync	Admistrative Systems

Figure 16.26: NTNU Silos

16.33.5 Model Evaluation 22. April 2015, Project manager 1 at NTNU

Role: Project manager, NTNU

Status: Quotation check conducted

Question nr	Score	Comment
Q1	5	Score 5 in an ideal world (the model) else 1. In an ideal world the model must be anchored at top level. Rector, deans, faculty management and management of all support functions and divisions as HR, Finance , IT, study and academic division. To make the model work in the real world compliance of decisions and guidelines are very important. However, at NTNU compliance of decisions and guidelines are lacking completely.
Q2	3.5	Can be solved by moving money (funding) after decisions
Q3	3.5	E.g: IAM project and Paga service bus. HR and Finance division has different interests in the same system Paga: HR and salary. Decisions to implement Paga in IAM context have been done 3 times. Risk analysis are conducted. Still there are conflicts. The issue is compliance. The IAM project is run by IT-Division. An IT project manager do not have the formal authority for compliance. The formal authority for compliance is at the process owner
Q4	3,5	Is related to the answer above. To much "silo" thinking and few long term goals. The process owners are not clear enough.
Q5	4	Must be in the "Unification" box in the model (figure 10.1) to make the security principles function. Processes and services must be coordinated for a secure and classified network. E.g. today there are no servers in secure zones.
Q6	5	Believe in TIA. A prerequisite is funding with TIA. The model only will work with investments.
Q7	3	No, it is not good enough because a model is not better than how it is followed up.
Q8	4	Assumes handling of guidelines meaning compliance. Ability and willingness to life cycle management. In the ideal world the model fits. But it requires more investments and life cycle management. For the model to function prerequisites as described must implemented.

Table 16.62: Score Model Evaluation 5

Further comments:

- After standardization in the Basis IT program, return on investment has not been measured. E.g. At the IVT faculty the local IT budget is "still the same" as before the Basis IT program.
- NTNU are not good at business cases.

-
- NTNU has many goals and many decision makers and process owners overlapping.
 - There is no return on investment measurement.
 - Hard to find a model that makes it interesting to do an improvement. There is a lack of incentives.
 - Economy model and annual budgets makes it hard to invest in something giving results in 5 years. However, programs makes it possible to think 4 years ahead.
 - The culture and IT at NTNU. IT should be a strategic instrument. IT is not seen as strategic instrument. IT is seen as a houseporter.
 - Projects should have funding both for development and life-cycle.

16.33.6 Model Evaluation 23. April 2015, System administrator at NTNU

Role: System administrator, NTNU IT-Division

Status: Quotation check conducted

Question no.	Score	Comment
Q1	4	Main concern is about knowledge within the IT-Monarchy. Managers like listening to sales personnel and do not find information themselves. This is caused by lack of domain knowledge. For Federal governance Archetype the advantage is to pull in the same direction. In addition efficiency gained caused by automation.
Q2	4	Same arguments as Q1. A Federal decision model achieve a more unified decision providing more predictability for the organization.
Q3	5	Providing a single interface for data is important. And it is important that NTNU own the data. In that way we can change source systems and target systems without large consequences for the organization.
Q4	4	This because it is easier to change interface, source system and target systems.
Q5	3	Federal decisions is taken for IT-Architecture and business. Decisions related to security should be at IT-Monarchy level.
Q6	5	The enterprise model and TIA provide the opportunity to select context.
Q7	5	
Q8	4	Federal decision model can fit for NTNU for the systems applied. Several stakeholders must agree in order to accomplish something in common. Business Monarchy will not function because there has not been any will to enforce decisions. Federal decision model is a necessity for accomplishment.

Table 16.63: Score Model Evaluation 6

Further comments:

- Emphasis on Monarchy, Feudal and Anarchy Archetypes is caused by a large degree of autonomy at NTNU.

16.33.7 Model Evaluation 27. April 2015, with Advicer and Senior advicer at NTNU

Roles: Adviser and Senior adviser, NTNU

Status: Quotation check conducted

Question no.	Score	Comment
Q1	NA	The model does not say anything about IT related to research versus administration. This depends on the process. This applies for Q1 to Q6. (Perhaps not for Q5) If the process live in one office only the model does not give any meaning. To make the model work, it requires tremendously oversight over organization and processes and in depth knowledge about organization and concepts.
Q2	NA	
Q3	NA	
Q4	NA	
Q5	NA	
Q6	NA	
Q7	3	At a university it should be Anarchy. The model distinguish between research and administration to a small degree.
Q8	3	At NTNU, there is a lack of will to distinguish between administrative processes, research processes and education processes. The borderline between administration at one hand and research/education at the other hand is unclear. There is a legacy after the last university merge. The result is a clear difference in the weighting of administrative and research processes at various units at NTNU.

Table 16.64: Score Model Evaluation 7

Further comments:

- About TIA: The challenge is different requirements. . Someone has to instruct how to apply the information from the data source. The data owner must decide in this issue. The data owner must have some control mechanisms.
- There is a lack of a common terminology. First you have to understand your own organization. There are different cultures at NTNU and the terminology is not standardized. E.g. What is a student? Does it include Phd students? The Norwegian Act relating to universities and university colleges defines the concept as a student. Still the practice at NTNU is different.
- If the data is extracted from the source without the understanding of context the information is flattened and it loose its value.
- TIA services must be tailored for any context. This is in dialogue with data owner to secure data quality. E.g:

-
- * Service for time schedule data.
 - * The generation of data must be correct.
 - * Ask the purpose of data. What are you going to use it for? E.g. the Cognos system have a different definition of a student.
- Creating models is very challenging. This because NTNU is so different. Perhaps one should divide IT for supporting administrative processes and IT supporting research processes. Still in some environments at NTNU there are persons working on both.
 - When starting the Schema solution project, including explanation of grades and appeals, the project was informed that a national standard solution for explanation of grades and appeals, in the Student Web/FS system, were under development.
 - The Ministry of Education is starting to look at roles for FS and Uninett. The Ministry will in larger degree govern the processes. E.g. the Ministry has initiated following projects:
 - * National register for exclusion.
 - * Database for approval of foreign study programs.
 - * A central report database for diplomas. Meaning a service to reach all results, degrees achieved, passed exams for single subjects, replacing paper based diplomas and transcripts applied for institutions and companies.
 - * These projects seems to be unknown for NTNU management. Or we don't know what the management know. The problem is a situation where all systems being integrated have an ideal goal for efficiency, and initiatives for change come from various levels such as: National level, institutional level and parts from the institutions. We all infringe upon the rights of others. Development at the administrative area has no master plan.

16.33.8 Model Evaluation 28. April 2015, IT-Director at NTNU

Role: IT-Director, NTNU

Status: Quotation check conducted

Question no.	Score	Comment
Q1	2,5	The ITIL change process is not in the model.
Q2	2,5	It is a challenge to map to-days world in the decision world described in the model.
Q3	3,5	
Q4	2	It is a challenge to map how e.g. process changes for salary is done in the model
Q5	3	
Q6	3	E.g. solution for electronic mail containing files from the archive system.
Q7	2	The model is not good enough as a target picture. The model is good at decision structure and ownership
Q8	3	The model fit for decision structure and ownership. The model is not clear enough regarding data flow.

Table 16.65: Score Model Evaluation 8

Further comments:

- About engagement model in figure 10.1 and governance archetypes as IT Monarchy and Anarchy. "None" is an governance archetype as well. Meaning decisions are not taken.
- Comment to table 4.1 Survey score. NTNU should have had a better score compared with UIO/USIT. This reasoned by that NTNU has customer center and a defined project method, PAM.

16.33.9 Model Evaluation 29. April 2015, interview with Project manager 3 and Senior engineer at NTNU

Role: Project manager and Senior engineer, NTNU

Status: Quotation check conducted

Question no.	Score	Comment
Q1	3	The model and mindset is correct, however the terminology used in the model does not fit for NTNU. One must take a step further which is the organization map for NTNU, add a familiar language/terminology and then match it to the model. E.g. Torgeir had a background from Cap Gemini. When he started at NTNU he spoke a different terminology (Cap). After one and a half year he spoke NTNU terminology and in NTNU images. It's about being understood. The mindset for the model is correct. However, the mindset must be adapted to NTNU context.
Q2	1	Again, the decision is not linked to the organization. E.g. Who should I call to take decision regarding purchase of a system? The decision hierarchy is lacking. Meaning lacking visualization of the the NTNU organization structure and "line of command".
Q3	3	Again, the decision is not linked to the organization. Better score than Q2 is reasoned by better overview with the enterprise model.
Q4	2,5	The model is ok related to system owner. Then the score would be 3.5. The model related to requirements for end user is not modeled. Then the score would be 1. When NTNU purchase new systems work processes are not considered. Changes in work processes are very cumbersome to implement at NTNU. There are many research communities each with their own habits. Departments are not accustomed to management and public administration. There is no decision authority. This is the reason for not underestimating the organization structure at NTNU. There is lack of compliance. We have no decision structure facilitating standardization and streamlined administration. And change management from the top is somewhat pulverized on the way down in the organization.
Q5	4	Figure 9.3 visualize Information Classification and Security Levels from NTNU Information Security Policy (77). Strongly recommend to take into the target picture. However, it requires more power to implement it. The big challenge is solo's and solo thinking. The model is ok. Responsibility at top management level. Lack of implementation.

Table 16.66: Score Model Evaluation 9, part 1

Further comments:

- NTNU is about to merge with several university colleges. If following governance model as is. We would have the same organization structure as today. If

Question no.	Score	Comment
Q6	4	When referring to figure 9.3 information model the score is 4. If referring to model 10.1 the score is 1.
Q7	3,5	The model is lacking a translation to NTNU context
Q8	2	The model is lacking a translation to NTNU context

Table 16.67: Score Model Evaluation 9, part 2

following the governance model as described in figure 10.1, the organization structure would be changed.

- The model requires governance archetypes as Anarchy, Federal and Business Monarchy translated to NTNU context so it can be understood by its users.

16.33.10 Model Evaluation 29. April 2015, Project manager 2 at NTNU

Role: Project Manager, NTNU

Status: Quotation check conducted?

Question no.	Score	Comment
Q1	4	The model can work fine. There is a lack of roles: Organizational challenge. The Financial Division has taken a larger ownership to data. This has been a maturity process. Will the model function in theory? Yes. Will the model function in practice? It's about maturity.
Q2	5	This because of standardization related to purchase/procurement. E.g. Purchase of one common HR/Salary/Economy system for the largest universities in Norway: NTNU, UIO, UIB and UIT. There is process to acquire a standardized Archive/filing system for the universities listed above as well.
Q3	2	Score 2 because we are very immature. The purchasing/procurement department must be coordinated regarding standards. Routines for purchase/procurement must be in place in such a way that it is possible to integrate new systems. E.g purchase of a new card access control system did not have the required interfaces in place. These interfaces are now under development. Therefore these integrations will take time and slow down deployment for the system. The purchase/procurement was conducted through a Scandinavian purchase agreement.
Q4	1	Score 1 is about organization culture. E.g. The Reception Center (Service desc) and the Orakel Service (Central IT user support at NTNU). Local IT user support service as the Department of Computer and Information Science develop at NTNU its own practice. HPSM will be applied as a user support tool for local IT. Standardization of tools for the service desc make a foundation for collaboration and only interface to deal with both for the end user and 2. line support. You can standardize and streamline the tools. Standardizing and streamline the organization is much harder.
Q5	1	Score 1 is reasoned by answers for Q3 and Q4. It is about maturity at NTNU. When goals related to Q3 and Q4 are achieved then goals related to Q5 and Q6 can be achieved. It's about doing things in order.
Q6	1	See answer above. And see figure below.
Q7	4	Yes, with reservations, I can not take in all information when presenting the model in only one hour.
Q8	4	Yes, with the conditions referred to. It will take time and it is matter of maturity.

Table 16.68: Score Model Evaluation 10

Further comments:

- The information model figure 9.7: TIA-FS Information Model display how FS information is linked against context. The information model does not display who is responsible for information appears based on two data sources. E.g. Roles both from sources FS and Paga. Who own the data in the grey zone? See figure below.

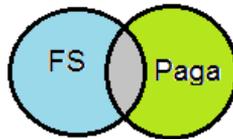


Figure 16.27: Data ownership grey zone

16.33.11 Model Evaluation 21. April 2015, Stig Vidar Nordgrd

Purpose for model: Govern how decisions are made among stakeholders concerning integration at NTNU.

Email: stig.v.nordgard@ntnu.no

Purpose: Competency questions evaluating the model (figure 9.1) directly.

Question no.	Score	Comment
Q1	4	Following decision types regarding IT-operation are regulated by the engagement model: IT-principles, IT infrastructure, IT Architecture, Business applications, IT prioritization and investment. The Unification operation model requires a Federal governance archetype. The EA To-Be represents a planning map making it possible to plan changes and see the impact of changes. Model is lacking concerning decisions related to IT operations change process.
Q2	3	Orders are about IT prioritizing and investment. Federal decision input and Business Monarchy decision. The model does not differ in small or large deliveries of integrations to new projects or systems. Small deliveries of integrations will be in two decision types: IT infrastructure (IT Monarchy decision) or Business Application (Federal decision). Here the model is unclear.
Q3	5	Decisions will be made for Business applications (Federal decision) and IT infrastructure (IT Monarchy decision). The enterprise model makes it possible to plan changes and detect the impact of changes.
Q4	3	Changes in work processes means Business Application decision type (Federal decision). However, the model does not answer decisions regarding requirements from system owner or end user.
Q5	3	Referring to figure 9.3: Information Classification and Security Levels. The classification is modeled. Who is responsible for taking classification and security decisions is not modeled. Still this is defined in the NTNU Information Security policy (77).
Q6	4	Referring to figure 9.7: TIA-FS Information Model. Data ownership is defined in figure 9.4. Decisions related to data/information and context is still the data owners responsibility. The model does not cover if new data/information appears when merging two data sources. Who is then responsible for making decisions?
Q7	4	It is a target picture for administrative processes (Unification). E.g. Research and innovation processes should not be standardized. "Unification is best suited to companies whose products and services are largely commodities. Companies more focused on innovation may find that the costs of standardization outweigh its benefits" (20, p. 38).
Q8	4	The model must be adjusted for research and innovation processes.

Table 16.69: Score Model Evaluation 11

Appendix K

16.34 Qualitative model evaluation

Qualitative model evaluation is performed by presenting the most important comments, suggestions and shortcomings to improve the model from the model evaluation interviews (Appendix J). The examples chosen to be presented will be colored by personal point of view.

Qnr	Evaluation comments
Q1	"To make the model work in the real world compliance of decisions and guidelines are very important. However, at NTNU compliance of decisions and guidelines are lacking completely." (?)
Q1	"The model does not say anything about IT related to research versus administration. To make the model work, it requires tremendously oversight over organization and processes and in depth knowledge about organization and concepts." (?)
Q1	"The ITIL change process is not in the model." (?)
Q1	"The model and mindset is correct, however the terminology used in the model does not fit for NTNU. One must take a step further which is the organization map for NTNU, add a familiar language/terminology and then match it to the model." (?)
Q2	"Again, the decision is not linked to the organization. E.g. Who should I call to take decision regarding purchase of a system? The decision hierarchy is lacking. Meaning lacking visualization of the the NTNU organization structure and "line of command".
Q2	"This because of standardization related to purchase/procurement. E.g. Purchase of one common HR/Salary/Economy system for the largest universities in Norway: NTNU, UIO, UIB and UIT." (?)
Q3	"The purchasing/procurement department must be coordinated regarding standards. Routines for purchase/procurement must be in place in such a way that it is possible to integrate new systems." (?)
Q3	"HR and Finance division has different interests in the same system Paga: HR and salary. Decisions to implement Paga in IAM context have been done 3 times. Risk analysis are conducted. Still there are conflicts. The issue is compliance. The IAM project is run by IT-Division. An IT project manager do not have the formal authority for compliance. The formal authority for compliance is at the process owner." (?)
Q4	"Each system supporting main processes education, research and support processes are build as silos. Important question? What is build with the intention to support what?" (?) See figure 11.1 NTNU Silos below.

Table 16.70: Qualitative evaluation

Qnr	Evaluation comments
Q4	"When NTNU purchase new systems work processes are not considered. Changes in work processes are very cumbersome to implement at NTNU. There are many research communities each with their own habits. Departments are not accustomed to management and public administration. There is no decision authority. This is the reason for not underestimating the organization structure at NTNU. There is lack of compliance. We have no decision structure facilitating standardization and streamlined administration. And change management from the top is somewhat pulverized on the way down in the organization." (?)
Q4	"You can standardize and streamline the tools. Standardize and streamline the organization is much harder." (?)
Q5	"It is not a prepared working system. There is not an appointed system owner providing clear requirements and guidance about security. There are principles for security, however they are not operationalized and followed up by management. (?)
Q5	"Must be in the Unification box in the model (figure 10.1) to make the security principles function. Processes and services must be coordinated for a secure and classified network. E.g. today there are no servers in secure zones." (?)
Q6	"The enterprise model and TIA provide the opportunity to select context." (87)
Q6	"Believe in TIA. A prerequisite is funding with TIA. The model only will work with investments." (?)
Q7	"It is a start. I must work on the issues I can influence and make an impact at my level." (2)
Q7	"At a university it should be Anarchy. The model distinguish between research and administration to a small degree." (?)
Q8	"Referring to figure 10.1. The "Unification" corner fit for administration. Standardization is positive for administration and production. While standardization becomes a constraint for research, development and innovation and fit the into the "Coordination" corner of the model." (?)
Q8	"The degree of standardization of business processes I can not govern at my level. However I can Influence the degree of integration. NTNU fit in the Coordination operation model referring to figure 10.1. E.g. I cannot standardize the HR process and I am not sure if the Rector can do it either." (2)

Table 16.71: Qualitative evaluation (continues)

Qnr	Evaluation comments
Q8	"Federal decision model can fit for NTNU for the systems applied. Several stakeholders must agree in order to accomplish something in common. Business Monarchy will not function because there has not been any will to enforce decisions. Federal decision model is a necessity for accomplishment." (87)
Q8	"At NTNU, there is a lack of will to distinguish between administrative processes, research processes and education processes. The borderline between administration at one hand and research/education at the other hand is unclear. (?)
Q8	"The model is an interesting input to a discussion. What decisions are decided where, by who and where? It seems like model tidy up in the decision structure. It is interesting that the model tidy up in various levels of decisions and degree of effect. Approach: What is the core tasks for research and education? NTNU has many systems with a variation in degree of integration and standardization." (90)

Table 16.72: Qualitative evaluation2 (continues)

"Each system supporting main processes education, research and support processes are build as silos. Important question? What is build with the intention to support what?" (?) See figure 11.1 NTNU Silos below.

Education process	Research process	Process support					
Studies	Reserach	HR	wage system,	HMS	Personal IT	collaboration	
LMS	Cristin Bibsys	Paga	Paga		Client	Calendar Mail Lync	Administrative Systems

Figure 16.28: NTNU Silos

Further comments to Qualitative evaluation:

- "There is a lack of a common terminology. First you have to understand your own organization. There are different cultures at NTNU and the terminology is not standardized. E.g. What is a student? Does it include Phd students? The Norwegian Act relating to universities and university colleges defines the concept as a student. Still the practice at NTNU is different." (?)
- "If the data is extracted from the source without the understanding of context the information is flattened and it loose its value." (?)
- "When starting the Schema solution project, including explanation of grades and appeals, the project was informed that a national standard solution for explanation of grades and appeals, in the Student Web/FS system, were under development." (?)
- "Anarchy archetype is often related to local IT supporting research and should not be standardized." (?) E.g:
 - * Lab experiments
 - * Cybernetic simulations
 - * Design
 - * Processing - geo data
- "NTNU are not good at business cases." (?)
- "NTNU has many goals and many decision makers and process owners overlapping." (?)
- "Projects should have funding both for development and life-cycle" (?)
- "The information model figure 9.7: TIA-FS Information Model display how FS information is linked against context. The information model does not display who is responsible for information appears based on two data sources. E.g. Roles both from sources FS and Paga. Who own the data in the grey zone?" (?) See figure 11.2 below.

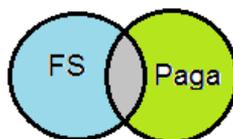


Figure 16.29: Grey zone data ownership

The model is weak at security (86; 89). How to improve security? See appendix J.

Appendix L

16.35 List of architectural artifacts

1. Chapter 2.6.2 Foundation of execution
2. Figure 5.1: NTNU Organization
3. Figure 5.2: Sketch of NTNU Enterprise Model
4. Figure 6.1: TIA system architecture
5. Figure 6.2: FS applications
6. Figure 6.3: NTNU enterprise data flow (legacy)
7. Chapter 8.1.1 Principles
8. Figure 8.2: TIA To-Be v03
9. Figure 8.3: Information Classification and Security Levels
10. Figure 8.4: Improved Business View Process and Function Owners
11. Figure 8.5: TIA application View To-Be
12. Chapter 8.4.3 Information Model
13. Figure 8.8: Data ownership and service complexity
14. Figure 8.9: Improved model for security and classification of information
15. Figure 8.10: TIA Technology To-Be v01
16. Figure 8.12: Proposed NTNU IT-Governance engagement model
17. Chapter 8.9.1 The Four Stages of Architecture Maturity
18. Figure 9.1: Best practice Integration Governance model
19. Figure 11.1: Adjusted NTNU Operation Model
20. Figure 11.2: Adjusted NTNU Engagement Model
21. Figure 11.3: NTNU Integration Governance Model
22. Chapter 12: Implementation steps

Appendix M

16.36 Draft for scientific article

This article report findings from my master thesis: Integration Governance. Norwegian University of Science and Technology, NTNU. Department of Computer and Information Science.

Enterprise Modeling and Architecture improves Integration Governance

Abstract.

The NTNU IT-Division has in recent years experienced a continuously increasing complexity in governance related to data integration and data flow in the NTNU organization. The demand for updated and quality assured data is in society constantly growing. This determine requirements for security, protection of privacy, tracking, aspects of law, technical aspects and economy (Life cycle costs for systems). These requirements necessitate improved organization and formal cooperation at NTNU (2). To improve the situation this master thesis introduce and define the concept Integration Governance. Based on best practice surveys and analysis a best practice Integration Governance model is presented. The model is evaluated by interviews of model stakeholders and SEQUAL a framework for evaluating model quality. The results from best practice analysis and model evaluation indicate that Enterprise model and Architecture improves Integration Governance.

1 Introduction

This paper report some research findings in my master thesis report: Integration Governance.

The paper is structured as follows:

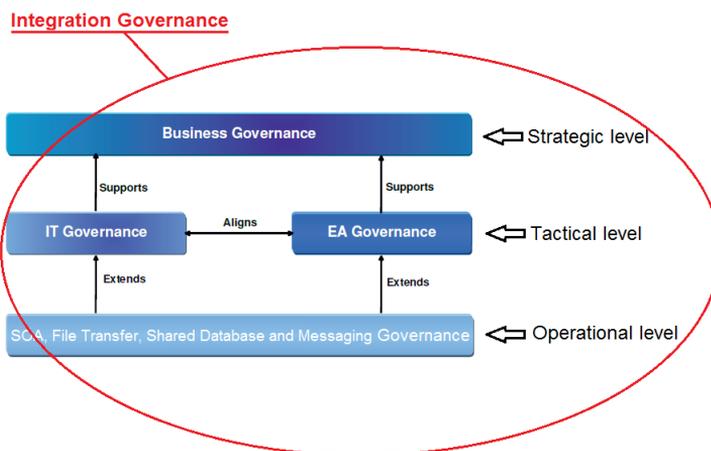
- **Section 2** Defines Integration Governance and presents composition of best practice survey.
- **Section 3** Presents Integration Governance best practice analysis.
- **Section 4** Presents best practice Integration Governance model.
- **Section 5** Presents model evaluation.
- **Section 6** Discusses indicated research findings.

2 Integration Governance definition and composition of best practice survey

An important part of the assignment (2) is to research best practice for integration governance at comparable enterprises. To conduct a Integration Governance best practice survey, a well reasoned questionnaire must be composed. This section describes definition of Integration Governance and composition of best practice survey and the reasoning behind the questionnaire.

Composition of Survey

The composition of the survey is based in the definition of Integration Governance. See figure 1 below.



Integration Governance

The questions in the survey are classified in three levels: Strategic, tactical and operational. Please note that the strategic, tactical and operational levels illustrated in the figure above may overlap. This however depends how the questions are perceived by the interviewee. Are questions in the survey perceived as relevant?

Reasoning behind questions

The questions are classified in strategic level, tactical level and operational level. The classification is reasoned by figure (Integration Governance) above.

Strategic level

Questions at the strategic level are based on the book Enterprise Architecture as a Strategy (20) presented chapter 2.6. It defines the operation model for an enterprise. The operational model is classified by the degree of business process standardization and the degree of business process integration presented See figure 3.3 below (20). The strategic level of questions aims to determine the operation model of the enterprise studied.

Characteristics of four operation models

Business process integration	High	Coordination <ul style="list-style-type: none"> • Shared customers, products, or suppliers • Impact on other business unit transactions • Operationally unique business units or functions • Autonomous business management • Business unit control over business process design • Shared customer/supplier/product data • Consensus processes for designing IT infrastructure services; IT application decisions made in business units 	Unification <ul style="list-style-type: none"> • Customers and suppliers may be local or global • Globally integrated business processes often with support of enterprise systems • Business units with similar or overlapping operations • Centralized management, often applying functional/process/business unit matrices • High-level process owners design standardized processes • Centrally mandated databases • IT decisions made centrally
	Low	Diversification <ul style="list-style-type: none"> • Few, if any, shared customers or suppliers • Independent transactions • Operationally unique business units • Autonomous business management • Business unit control over business process design • Few data standards across business units • Most IT decisions made within business units 	Replication <ul style="list-style-type: none"> • Few, if any, shared customers • Independent transactions aggregated at a high level • Operationally similar business units • Autonomous business unit leaders with limited discretion over processes • Centralized (or federal) control over business process design • Standardized data definitions but data locally owned with some aggregation at corporate • Centrally mandated IT services
		Low	High
Business process standardization			

Figure 1: Operation models

Tactical level

At the tactical level questions are derived from the Open Group SOA Governance Framework Technical Standard (26), the assignment given from NTNU IT Division

(2) and the Statoil Governance Document: IT Components (27) (Appendix M). The tactical level of questions aim to find best practice at the tactical level of the enterprise studied.

Operational level

At operational level questions are derived from Statoil Governance Document: It Components (27) and the assignment given from NTNU IT Division (2) The operational level of questions aim to find best practice at operational level of the enterprises studied.

3 Integration Governance best practice analysis

Enterprises categorization are based on surveys (Appendix A) at strategic level. See figure 4.1 below. The enterprise categorization is based on question 1 to 8a in the questionnaire (Appendix A, strategic level). In particular question 8a and 8b ask how the degree of business process integration and business process standardization is perceived by the interviewee. The interviewees answers make it possible to determine the respective enterprise operation model. The figure below aim to categorize the enterprises operation model based on best practice surveys conducted.

Characteristics of four operation models

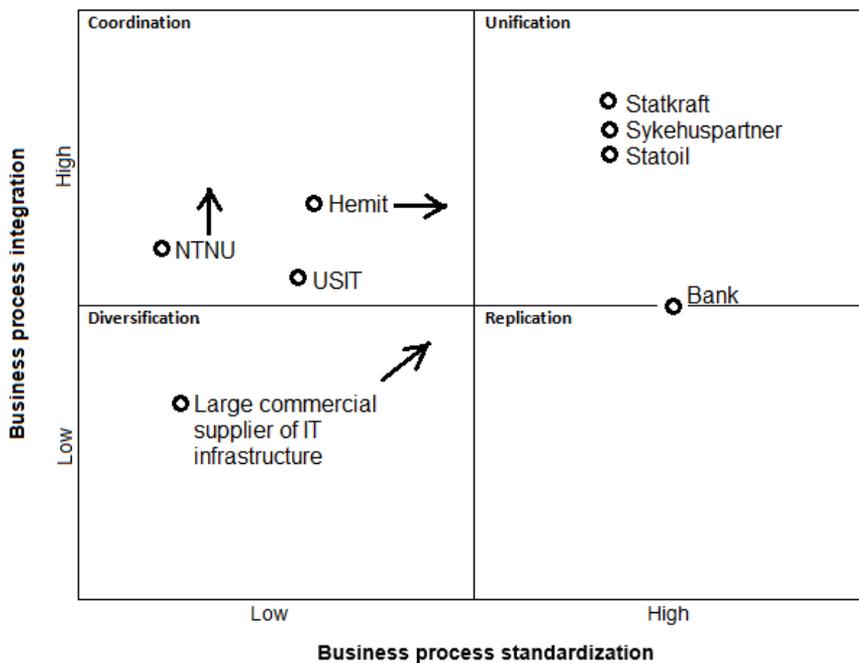


Figure 2: Enterprise operation model categorization

In the figure above there are some arrows attached to enterprises. It indicates a goal for the enterprise to change in that direction.

Best practice?

In figure (Enterprise operation model categorization) above there are three enterprises in the Unification operation model box. These enterprises are by the figure defined to have the best practice. The plotting of figure 2 is based on the interviewees

subjective perception regarding their enterprise in the surveys. How can I assume that three enterprises in the Unification operation model box actually holds a best practice?

To verify best practice. Each question in the survey is scored (Appendix B and Appendix C). The score indicates if the question asked represent an actual practice. The answers are scored like this:

- 1 point: The answer represents an actual practice.
- 0,5 point: The answer represents a partly or incomplete actual practice.
- 0 point: The question is not answered or irrelevant.

The score is for each enterprise in the survey summarized at strategic, tactical and operational level. See table below. Note the table Survey score (Table 2) does not tell

Enterprise/statistics	Strategic	Tactical	Operational	Total score
Sykehuspartner	15	50,5	20	85,5
Statoil	15	49,5	18	82,5
Statkraft	15	42	20	77
Hemit	15	41	19	75
Bank	11	41	18,5	70,5
IT supplier	15	33	17	65
NTNU	13	33	17,5	63,5
USIT/UIO	13	30,5	14,5	58
Number of questions	15	51	21	87
Average score	14,00	40,06	18,06	72,13
Standard deviation	1,41	7,02	1,69	8,99

Table 1: Survey score

anything about a best practice. The table give score whether there is a actual practice for the questions given at strategic, tactical and operational level. In the table above the three enterprises with the highest score is respectively Sykehuspartner, Statoil and Statkraft. These enterprises are the same plotted in the Unification Box (figure 2). These enterprises actually have the highest score at each level. (Exception is Statoil at operational level.) This indicates there is a correlation of best practice between the strategic, tactical an operational level.

Their answers (Sykehuspartner, Statoil and Statkraft) in the surveys at strategic, tactical and operational level will be the basis for best practice for Integration Governance. Based on the surveys I may assume these three enterprises are the most competitive and agile, thereby having the best practice studied.

4 Best practice Integration Governance model

This section aim to align Enterprise Model and Architecture (EA) To-Be, based on best practice analysis, with Foundation of Execution (20)

To Build a Foundation of companies must master three key disciplines (20):

1. Operation Model
2. Enterprise Architecture (EA)
3. IT engagement model

NTNU Foundation of Execution based on Best Practice

The Enterprise architecture To-Be represents a best practice with following Foundation of Execution:

1. Operation model: "Unification" representing high degree of business process standardization and high degree of business process integration (20):
2. Enterprise architecture (EA): Figure 8.2 (1): TIA To-Be represents Enterprise Model and Architecture To-Be
3. IT engagement model. Figure 8.12 (1): Proposed NTNU IT-Governance engagement model

The best practice Integration Governance model cover different architectural views representing similar and overlapping architectural structures compared to TOGAF views presented in (1)chapter 8.

How does the EA To-Be and the Engagement Model affect each other?

A definition of EA is: "A formal description of an enterprise, a detailed map of the enterprise at component level to guide its changes" (19). The IT engagement model describes who is giving input to and taking which decisions. To be able to perform the right decisions EA To-Be represents the detailed map of the enterprise at component level to guide its changes.

The Integration Governance master thesis (1) presents an example project: NTNU Schema Solution project. This project faced challenges regarding integration of business processes, standardization of business processes and governance. For the NTNU Schema Solution project an implemented EA To-Be and and implemented Engagement model the consequence would be: Decision makers will have an ability

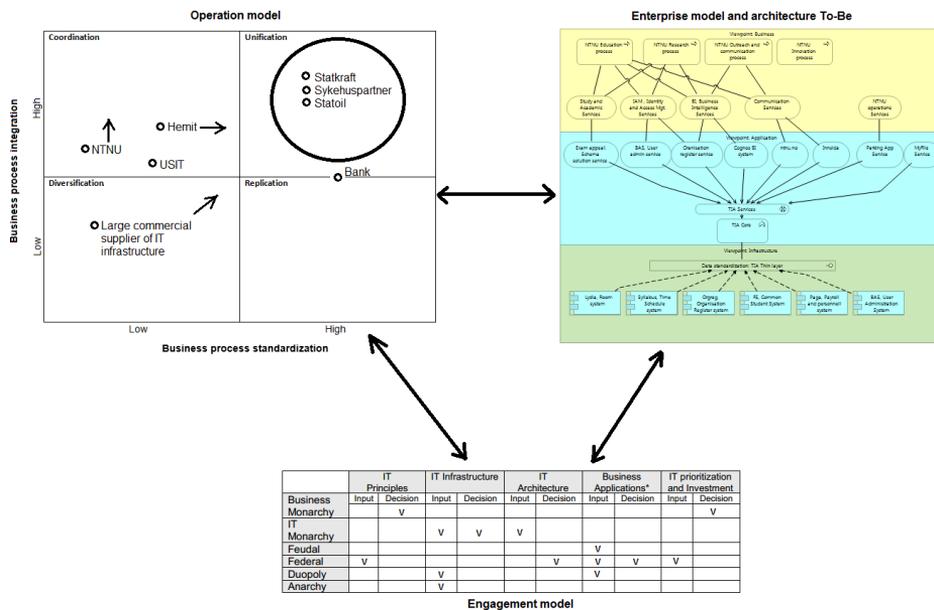


Figure 3: Best practice Integration Governance model

to see the requirements for a Schema Solution from an Enterprise perspective. Also the consequence would be the ability provide an understanding and perception of complexity components are related (EA To-Be) and why an engagement model is required. This displaying the complexity regarding data ownership, process ownership, how services supports the processes and the impact of changes.

5 Model evaluation

In this section the best practice Integration Governance model (figure 3) is evaluated. Does the model meet its purpose? And does the model fit to NTNU? This chapter presents: Purpose of the model, quantitative evaluation and evaluation by SEQUAL.

Purpose of the model

Purpose of the model is to support the assignment and problem definition described the Integration Governance master thesis (1) "The main purpose of the Integration Governance model is to govern how decisions are made among stakeholders concerning integration at NTNU".

Quantitative evaluation

Quantitative model evaluation is conducted by interviews Integration Governance master thesis (1)(Appendix J). The questions below are based on the purpose of the model. The main purpose of the Integration Governance model is to govern how decisions are made among stakeholders concerning integration at NTNU. The best practice Integration Governance Model (figure 3) is referred to as the model. Does the model Govern how decisions are done regarding:

- Q1: IT-operations?
To what degree? (1 - 5)
- Q2: Orders (Delivery of integrations to new projects or systems)?
To what degree? (1 - 5)
- Q3: Change in source system, interfaces or target system
(Change in applications)?
To what degree? (1 - 5)
- Q4: Change of requirements by system owner or end user
(Meaning change in work processes)?
To what degree? (1 - 5)
- Q5: Security and categorization of information?
To what degree? (1 - 5)
- Q6: Information and context
(Data and information and have different meaning depending on context)?
To what degree? (1 - 5)

Control questions:

- Q7: Does the model provide a target picture for governance of integrations processes (model).
To what degree? (1 - 5)
- Q8: Does the model fit to NTNU?
To what degree? (1 - 5)

Evaluation score is displayed in the table 1 Score model evaluation below. The table contains score from evaluation interviews (Enr) and questions based on purpose of the model (Q1-Q8).

Model evaluation by SEQUAL

Evaluation by interviewing model stakeholders and competency questions evaluates the whether the purpose of the model is meet. These evaluation methods do not

Enr	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
1	5	4	4	4	2	4	4	4
2	4	3	4	3	3	3	3	2
3	na	na	na	na	na	na	-	-
4	3	4	3	4	1	4	3	4
5	5	3.5	3.5	3.5	4	5	3	4
6	4	4	5	4	3	5	5	4
7	na	na	na	na	na	na	3	3
8	2.5	2.5	3.5	2	3	3	2	3
9	3	1	3	2.5	4	4	3.5	2
10	4	5	2	1	1	1	4	4
Avg. score	3.8	3.4	3.5	3	2.6	3.6	3.4	3.3

Table 2: Score model evaluation

necessarily provide an objective evaluation of the quality of the model. Therefore a more objective evaluation method as SEQUAL might be useful for evaluating the quality of the model represented by figure 3

- **G**, sets of goals of the modelling task:
 - * "To govern how decisions are made among stakeholders concerning integration at NTNU" (1)(chapter 1.3).
 - * After evaluation, "Create integration governance model for NTNU." (1)(chapter 1.3).
- **D**, the domain i.e., the set of all statements that can be stated about the situation. The Goal of modelling typically restricts the domain to only those things relevant to achieve the goal. Domain **D**:
 - * NTNU, refer to problem definition: "Study and evaluate how enterprise modeling and architecture improves integration governance at NTNU" (chapter 1.3).
 - * TIA and FS, "Study TIA Case. Focus on FS, Common Student System" (1)(chapter 1.3).
- **L**, the language extension, i.e., what can be expressed by the modelling language used.
 - * Archimate (Archi)
 - * Foundation of execution with modelling notation for Operation Model and Engagement model (20).
- **M**, the externalized model itself.

-
- * The model represented by figure 9.1 Foundation of execution based on best practice.
 - * And the EA in figure 3 including modelling views supported by TOGAF presented in chapter 8 (1). EA To-Be.
 - **K**, the explicit knowledge that the audience (both modelers and model interpreters) have on the domain.
 - * The modeler and model interpreters (the model stakeholders listed in chapter 10.1.1) have a comprehensive domain knowledge. Referring to their roles at NTNU.
 - **I**, the social actor (human) interpretation of the model.
 - * Referring to the stakeholders various roles and perspectives in the NTNU Organization listed in chapter 10.1.1 (1).
 - **T**, the technical actor (tool) of the model.
 - * Referring to the stakeholders various listed in chapter 10.1.1 (1). with technical background i.e. developer and system administrator.

The following evaluation qualities from SEQUAL are selected to evaluate the model represented by figure 3: Semantic and perceived semantic quality and pragmatic quality.

Semantic and perceived semantic quality

Semantic quality was originally defined as correspondence between the model and the modelling domain (69, p. 227).

The modelling domain **D** is NTNU with focus on TIA (Service Oriented Information Architecture) and FS (Common Student System). This includes data source systems, services, dataflow, involved processes, stakeholders and organization represented by EA To-Be supported by TOGAF (1)(chapter 9). In addition the modelling domain is the foundation of execution best on best practice figure 3, the model **M** representing operation model, engagement model and EA To-Be. Stakeholders of the model have been interviewed (1)(Appendix J) to find out if the model meets its purpose. The main purpose of the Integration Governance model is to govern how decisions are made among stakeholders concerning integration at NTNU (1)(chapter 1.3). When referring to table 2, Score model Evaluation, all questions have an average score at medium or above except for Q5. This indicates that there is correspondence between the model and the modelling domain.

Validity:

Validity mean that all statements made in the model are regarded as correct

and relevant for the problem. M= Based on the interviews and table 2, Score model evaluation, the model tend to valid.

Completeness:

Completeness means that the domain model all the statements which would be correct and relevant about the domain. D= Based on table 2: Score model evaluation and interviews, following issues might make the model incomplete:

- "The model and mindset is correct, however the terminology used in the model does not fit for NTNU. One must take a step further which is the organization map for NTNU, add a familiar language/terminology and then match it to the model." (?)
- "At a university it should be Anarchy. The model distinguish between research and administration to a small degree." (82) and "At NTNU, there is a lack of will to distinguish between administrative processes, research processes and education processes. The borderline between administration at one hand and research/education at the other hand is unclear." (82)
- "Referring to figure 3. The "Unification" corner fit for administration. Standardization is positive for administration and production. While standardization becomes a constraint for research, development and innovation and fit the into the "Coordination" corner of the model." (89)
- Q5 in table 2, Score model evaluation, has has average score below medium. Q5 concern about security and classification.

Pragmatic quality

Pragmatic quality as defined relates to the comprehension of the model by participants (69, p. 231). Two aspects can be distinguished:

- That the human stakeholders of the model is correct relative what is meant to be expressed in the model. When interviewing the stakeholders for evaluation, relevant concepts related to the model was first presented. The presentation counted about 40 pages. The duration for the interview sessions including the presentation of concepts and the model figure 3 were about 1 to 1 and half hours. This indicate there is lot of information to perceive in a short time. I.e. "I can not take in all information when presenting the model in only one hour" (85). The model to be evaluated figure 3 includes the Enterprise Architecture (EA) based on best practice EA To-Be. Considering the interviewees short evaluation time and stakeholders various positions at NTNU it is understandable that the model is perceived differently. Still, based on the table 2, Score model evaluation and interviews, it might be concluded that the model meet its purpose.

-
- That the tool interpretation is correct relative to what is meant to be expressed in the model. A challenge can be that the user find the concepts of the Foundation of Execution represented in figure 9.1 unfamiliar. I.e. "The model and mindset is correct, however the terminology used in the model does not fit for NTNU. One must take a step further which is the organization map for NTNU, add a familiar language/terminology and then match it to the model" (83).

6 Discussion

This section discusses the hypothesis H1 presented in paper (1)(chapter 1.4).

H1: Enterprise Modeling and Architecture improves Integration Governance

The best practice model is represented by figure 3. The model is based on the concept Foundation of Execution (20) which consist of: The Operation Model, The Engagement Model and the Enterprise Architecture (EA). The model is represented by figure 3 is defined as best practice for Integration Governance. Please notice that enterprise modeling and architecture is a part of the best practice Integration Governance model represented by figure 3. The model 3 indicates mutual dependencies between the operation model, enterprise model/EA To-Be and the IT Engagement Model.

First in the section (How does the EA To-Be and the Engagement Model affect each other?) there is an indication of that Enterprise Modelling and Architecture improves Integration Governance: "To be able to perform the right decisions EA To-Be represents the detailed map of the enterprise at component level to guide its changes."

Second there is an additional indication of that Enterprise Modelling and Architecture improves Integration Governance in (1)(chapter 9.1.5): "For the NTNU Schema Solution project an implemented EA To-Be and and implemented Engagement model the consequence would be: Decision makers will have an a ability to see the requirements for a Schema Solution from an Enterprise perspective."

Finally the model evaluation conducted in section by the evaluation score in the table 2 indicates that enterprise modeling and architecture improves Integration Governance. For Q7 in table 2: "Does the model (figure 9.1) provide a target picture for governance of integrations processes" the average score is 3.4 of (1-5). And for Q8 in table 2: "Does the model (figure 3) fit to NTNU?" the average score is 3.3 of (1-5). In addition a statement from the model evaluation interviews is interesting: "The model and mindset is correct, however the terminology used in the model does not fit for NTNU. One must take a step further which is the organization map for

NTNU, add a familiar language/terminology and then match it to the model” (83)

There are three indications reported above that Enterprise Modelling and Architecture improves Integration Governance in this thesis. However, this can not be finally concluded. It is reasoned by:

1. Best practice is based on surveys conducted (1)(Appendix B) at only 7 external enterprises. The statistical basis is too small.
2. Model evaluation is based on 10 interviews (1)(Appendix J). The statistical basis is too small as well.

Bibliography

Not completed

Appendix N

16.37 Statoil Governance document

Statoil Governance document: IT Components

With Permission from Harald Wesenberg, Leading Advisor Solution Architecture at Statoil

This appendix is enclosed representing some best practices

IT Components

Information technology (IT)
Technical and professional requirement, TR1621, Final Ver. 5.01, valid from 2013-10-30

Owner: Process owner IT

Validity area: Corporate technical requirements/On- and offshore; Statoil/On- and offshore

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1 Objective, target group and provision

The purpose of this document is to provide a common set of requirements governing acquisition, development, deployment, maintenance and operations of IT components and software solutions. This requirements should

- Ensure Statoil governance of technology usage, functionality and information usage
- Ensure consistent use of technology
- Enable IT solutions that can provide simple and consistent management of data
- Ensure that the solutions are robust when technology changes, when the surrounding systems changes or when usage changes
- Ensure that management of the components, software and information are effective
- Ensure that the total cost of ownership for the portfolio of solutions are as low as possible

The target groups are Process owners, Line Management, IT professionals, IT service providers, IT procurement, Asset Owners of activities with IT components and IT staff functions.

Document is warranted in Functional Requirements for [Information Technology \(FR15\)](#).

This document is issued, maintained and distributed by process owner IT.

2 Requirements

2.1 General requirements

Solutions exist in the context of business processes. This means that solution boundaries must relate to business boundaries. For more info on structuring solution boundaries, see Appendix B.

Solutions should work in a global high latency/low bandwidth infrastructure.

2.1.1 Life cycle Status

An updated list of allowed and preferred IT technologies and solutions are published in the [Information Technology Network Portal](#).

The following life cycle statuses are used:

Emerging	A product, solution or component that is regarded as interesting for Statoil and where we monitor the development of the product/solution/component for future use. The implementation hasn't been decided yet.
Soon	A product, solution or component that has been decided to be introduced into Statoil.
Now	A product, solution or component that is currently in use and recommended for global use across Statoil.
Careful	A product, solution or component that: <ul style="list-style-type: none"> • has an uncertain future in Statoil • is recommended as a substitution for standard solutions within a specific area (process area, organization unit or location).
Freeze	A product, solution or components are set to freeze. All usage shall have a reference to an approved deviation permit. The deviation permit shall include a

	plan for replacement or phase out, with an end-of-life date specified.
Out	A product, solution or component where there are activities to phase out all usage in Statoil.

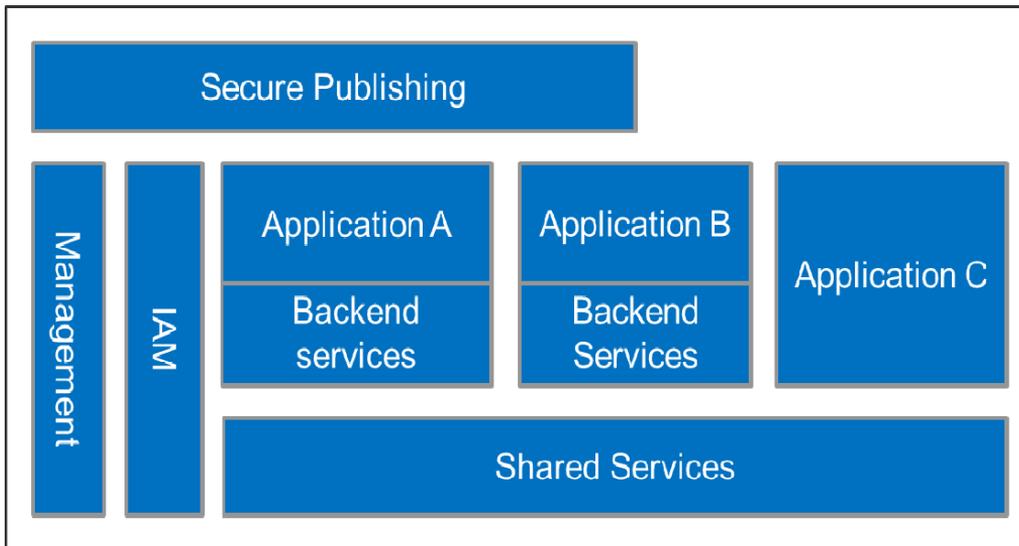
All new use of IT solutions that have status other than “Now”, or to change the status of an IT solution needs to be approved by the relevant process owner. All new use of IT technologies/components that have status other than “Now” needs to be approved by the chief engineer IT or relevant leading advisors within IT.

When setting life cycle status on solutions, the life cycle status of the underlying technologies is considered risks that must be managed in the solution context. A solution may well have life cycle status “Now” even if underlying components and technologies have life cycle status “Careful” or “Freeze”.

2.2 IT Infrastructure

All new applications shall be placed in a zoned environment. A zone contains only one application with a corresponding security regime specific for that application with a controlled access to other zones and shared services. A zone includes user interface logic, frontend services, business logic and data (backend services). It is only the applications frontend services and user-interface logic that are exposed outside of a zone. The same architecture is used both for external facing applications (Statoil partners, vendors, etc.) and internal facing application (Statoil users).

The architecture doesn’t enforce any limitation on the physical location of an application. The application can be in a Statoil datacenter, sourced by a 3rd party vendor, cloud service, etc. All applications must be tested and verified to ensure that they can be deployed at other locations.



Common infrastructure management services, identity management (IAM) and access management can be consumed from the solutions inside the zones.

The architecture shall support both two-factor, one-factor and non-factor solutions. There shall be documented practices for moving applications and data from one zone to another runtime environment hosted by another datacenter or datacenter provider.

Applications must be classified according to importance and criticality. High critical applications must execute on a high availability infrastructure.

2.3 Computing Platforms

Statoil shall have an identified set of computing platforms available. We shall have enough platforms to be able to install the applications and functionality we need. Statoil prefers applications and information systems based on these platforms.

Platforms determine the tools that are most efficient to use to manage, configure, and integrate the application. In general there are platform specific tools that are most efficient to use for certain purposes within a platform. Sometimes platforms can overlap; i.e. the same database system can be used by several platforms. Due to the cost related to support a multitude of platforms, we minimise the number of platforms that are supported.

A context analysis should be done when deciding on platform. Introducing new platforms should not be done when introducing single applications. All new platforms are to be approved by chief engineer IT.

The platforms are of two kinds: technical platforms and enterprise software platforms.

2.3.1 Technological Platforms

Statoil will work closely with our vendors of technological platforms to understand and influence the roadmap and development of the platform.

When using open source software (e.g. Spring, Linux) Statoil must use enough effort to ensure that we understand and participate in the development of the open source component. This can be achieved through the partnering with a commercial vendor that provides support and development (e.g. Spring and Red Hat).

For all development efforts we require the use of commercially supported and proven application frameworks addressing major complexities and key areas of the software architecture. We do not develop frameworks internally in Statoil. When the computing platform or specific needs do not require otherwise, we prefer the use of Microsoft .Net development platform.

2.3.2 Enterprise Software Platforms

Large enterprise software comes with a technological platform and corresponding ecosystems. Examples are SAP, OpenWorks, Petrel, Endur etc.

Configurations and customization in such software ecosystems shall utilize the vendors preferred technologies and practices.

2.3.3 Packaged Applications

Packaged or COTS (Commercial off the shelf) applications represents the majority in our software portfolio.

The vendor is responsible for its product and should be accountable for all changes made to the core of the product. Statoil will work closely with vendors of distinct and core solutions to ensure that Statoil's requirements are met in the product core thus reducing the need for Statoil specific customisations.

We do not make commercial products internally.

A significant share of support fees paid to the vendor should contribute to further product development. If this is not the case, the solution is not viable in the long run, and should not be introduced into Statoil. If this applies to an existing solution, the solution should be phased out in a controlled manner to avoid future problems with the vendor and solution.

2.3.4 Configuration vs. customisation of Enterprise Software Platforms and Packaged Applications

For categorisation of configuration and customisation see appendix E.

Statoil has the following requirements to configuring and customising:

- Solutions are configured to meet business needs.
- Selected customisation can be considered if configuration is not sufficient to meet business needs
- Comprehensive customisations are done loosely coupled to the commercial acquired software.

Configurations and customisations are software source code, and must be managed accordingly. A packaged application shall have mechanisms to maintain configurations and enhancements as software source code.

Configurations and customisations shall be subject to the same requirements as custom developed code, including version management, configuration management, testing, deployment models and more as described in section 2.4 below.

2.3.5 Determining architectural fit when acquiring IT components/solutions

The architectural fit of an IT component or solution must be determined as part of the acquisition and/or implementation process. This analysis must cover the following areas:

- **Process integration:** How well will the work practices from using the component/solution candidate integrate with already existing process in Statoil? Do the boundaries of the work practices reflect the already existing process boundaries?
- **Solution integration:** How well will the component/solution candidate be integrated with surrounding components/solutions using Statoil's preferred integration mechanisms and technologies as described in this document?
- **Information integration:** How well will the component/solution candidate be able to exchange information with surrounding components/solutions without complex transformations? How well will the component/solution be able to fulfil its master data responsibilities, if any? How well will the component/solution be able to deliver necessary information to the corporate business intelligence solutions? Do we have access to the information model or suitable service model?
- **Technological integration:** Will it run in our existing and preferred technological platforms?

A component/solution that has a better architectural fit is preferred over components/solutions with poorer architectural fit, even if the components/solutions with poorer architectural fit have better functional coverage, as long as the functional coverage in both solutions is sufficient. This is due to the massive

costs incurred when integrating components/solutions with poor architectural fit into existing solution landscapes.

2.3.6 Solutions hosted externally

Statoil allows solutions to be hosted and delivered by reputable, commercially viable external vendors.

Requirements to solutions hosted by external vendors

For solutions hosted by external vendors, Statoil has the following requirements

- Based on a risk assessment:
 - Solutions must be hosted in a Tier III or Tier IV data centre
 - The solution provider must be SSAE No.16 [SSAE16] certified or similar
 - The hosting provider must be SSAE No. 16 [SSAE16] certified or similar
 - Contracts with solution and hosting providers shall include a “right to audit” clause
 - The authorisations and authentications must be done using solutions supported or approved by Statoil.
- Statoil have ownership of access rights to solutions and data.
- The identity provider must be approved by Statoil.
- A need for Statoil specific Service Level Agreements must be evaluated
- Integration points and interfaces for process, information, solution and technical integrations must be identified and maintained by Statoil
- Master data access, distribution and usage must be identified and maintained by Statoil
- Configurations and customisations made for Statoil must be identified and maintained by Statoil

Exit strategy

For all externally hosted solutions, an exit strategy must be in place before the use of the solution commences. This strategy must cover discontinued use of the solution and mitigating actions such as moving to another vendor and vendor bankruptcy. The strategy must include provisions for accessing our data and transferring our data out of the hosted solution if necessary.

2.4 Software Development in Statoil

Statoil solutions are designed and built according to sound architecting principles with well-known and secure deployment scenarios [Software Engineering]. Best practices for software engineering cover multiple disciplines and are described in: [Standards and Guidelines for Software Engineering](#).

2.4.1 Software Engineering process

FR15 and the Statoil Book mandate incremental delivery and iterative development. In Statoil we have selected Scrum as the framework to support this, and in short this means that we establish solutions by:

- **Inspect & Adapt** - so we can learn and adjust as we work
- **Prioritised Backlog** - so the most important and/or risky requirements are implemented and tested first
- **Time boxed incremental deliveries** - so risk is reduced and learning is maximised by delivering early and often
- **Cross functional teams** - that can work on and understand the complete set of problems and benefits

It is an explicit requirement that the quality intentions stated by IT Service management and the roles and responsibilities defined to support this are fully streamlined into the software engineering process. Where hand-offs exists, these should be fast and smooth with minimal waste introduced.

Where Statoil engage Scrum teams it is an explicit requirement that both IT Service management roles and Scrum teams work closely together to incorporate the IT Service management quality intentions into the Scrum Definition of Done (DoD) specification.

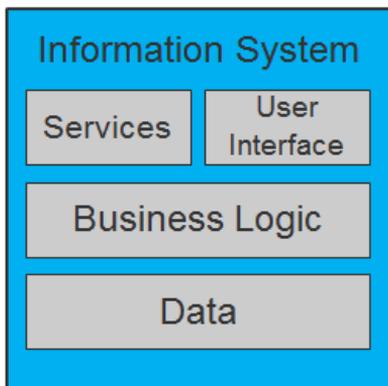
From an IT perspective, Solution Quality are measured by

- Minimizing technical debt.
- Automation of the build, test and deployment processes.
- Facilitate cost efficient monitoring.
- Being self-contained and autonomous to the highest possible degree.

This is described in appendix F.

2.4.2 Individual Information Systems and Applications

Each application should have distinct layers for presentation, services/integration, business logic, and data persistence subsystems. When flexibility and/or performance demands require it, all layers should be designed for to be substituted and be able to be moved to different network locations:



1. The presentation layer must be explicitly defined and have a clear interface to any services used and the underlying business logic layer
2. If flexibility is deemed necessary, the presentation, services, and business logic layers must be designed in such a way that the presentation layer can substituted with an alternative user interface
3. It shall be possible to use the presentation layer or access the services layer from a remote location.
4. It shall be possible to create or integrate alternative business logic on top of the data layer.
5. It shall be possible to move the data to new storage location.
6. Data shall be used by a presentation layer or a service through a business logic layer.
7. Business logic and data shall be split up into autonomous services.

Applications must be classified according to importance and criticality. High critical applications must execute on a high availability infrastructure.

Information systems shall have mechanisms for surveillance and capacity monitoring from a central operational manager.

All applications and information systems shall be autonomous, e.g. one information system shall be able to undergo maintenance and upgrades independent of other information systems.

Applications and information systems shall use open, and standardised IT infrastructure services. Examples of such services includes access control, authorisation, graphical subsystems, web infrastructure, user interface, data storage, databases, document storage, backup, data formatting, reporting, runtime framework, middleware, messaging, workflow, integration technologies, management, monitoring, OS and network.

The vendor must have a plan for user and system support, and an organisation to manage this.

2.4.3 User Interface

Statoil prefers application to be delivered to the end users via internet-enabled clients or fit for purpose interfaces including task based interfaces and/or mobile device interfaces. Whether to use HTML, Rich Internet Applications, or separate specialised client technologies is a trade-off between ease of deployment and required functionality.

The business objectives are achieved through the target user group and their capabilities and experience of the application, and are therefore a key focus during the entire development cycle.

2.4.4 Software Integration

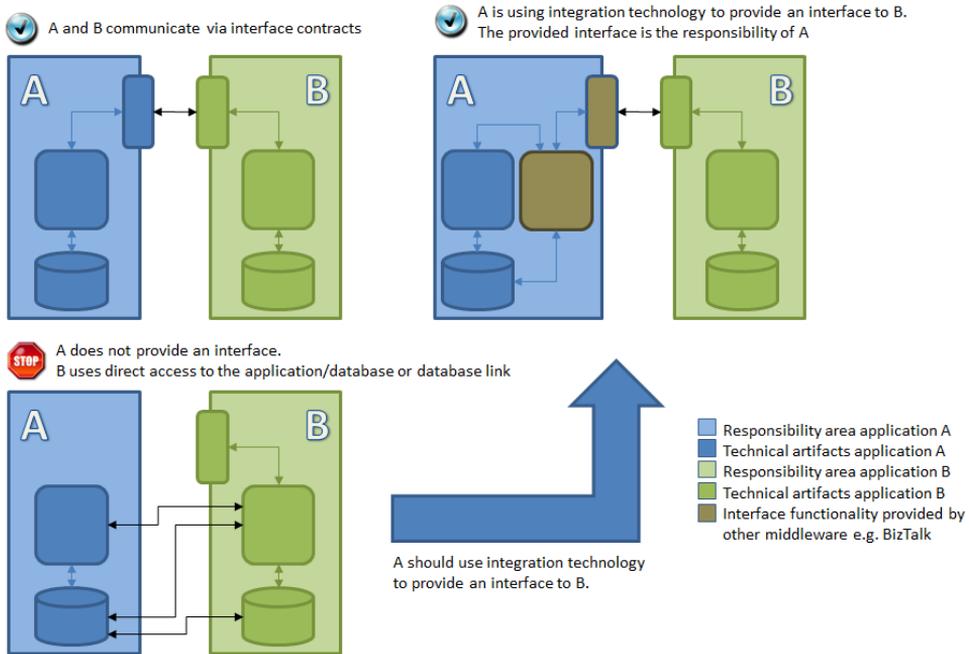
Software integration shall be based on the principles of SOA and described in the context of its business supporting function, with a focus on the boundaries and interfaces. We prefer domain language over technical terminology.

Software integration shall

1. Have a clearly defined set of well documented and maintained interfaces that
 - a. are generic and re-usable
 - b. abstract away from the underlying system and instead are based upon the business domain.
 - c. ensure the confidentiality and integrity of information and functionality.
2. Be able to integrate to different technical solutions and backend business solutions.
3. Utilize and leverage standards to lower integration cost.
4. Secure functionality and information implemented by the applications.
5. Be integrated based on technical contracts and clear responsibilities.

Where an application doesn't have the ability to provide its own interfaces, existing integration technology such as Microsoft BizTalk should be used to provide a service layer.

In the figure below A & B represent the technical responsibility areas of two different applications. The figure illustrates different integration scenarios



Integration can be done at four levels:

1. GUI integrations e.g. portals
2. process integrations e.g. workflows
3. application integration e.g. messaging
4. data integrations e.g. Extract, Transform and Load (ETL)

Functionality and applications that are accessible from a portal shall be able to be started and maintained independently (autonomous systems).

2.5 Data Storage and architecture

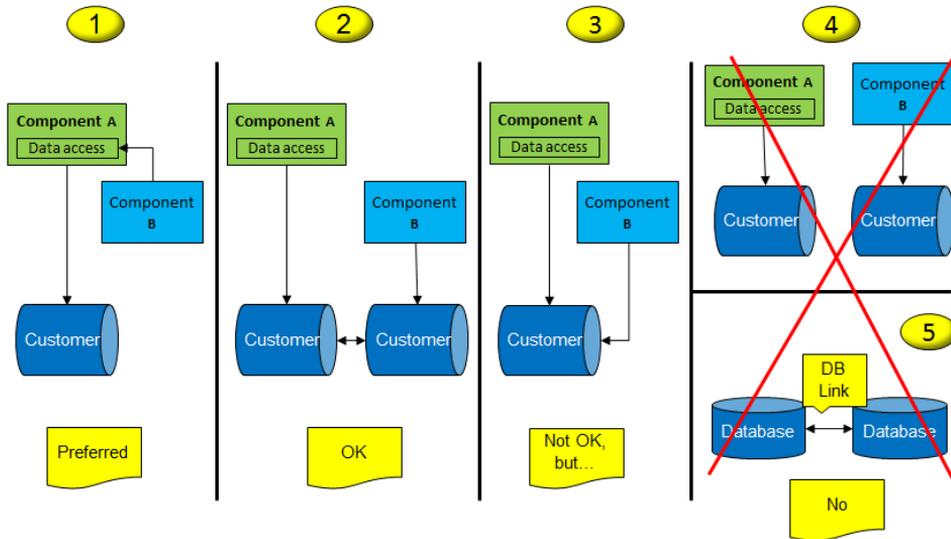
In general we avoid using the same database for several independent information systems.

Digital data exists in the context of information systems.

In Statoil we use that same information in different processes and for different purposes, most commonly is master data and metadata. We prefer the same master data and metadata to be used across applications and information systems.

Data exchange is needed due to overlapping data models in the information systems, including master data and metadata.

Creating runtime dependencies based on integrations shall be avoided whenever possible, for example will database links across computing platforms create dependency.



1. The architecture in scenario 1 is preferred, i.e. same data in one corporate database instance. The access to the data is requested through a central component / service when such services exist. To ensure autonomous solutions (2.4.1), Component B in the illustrations shall not rely on a synchronous integration with Component A to be operational.
2. The architecture in scenario 2 is acceptable. Same data in different databases shall be synchronised and a specified master / slave relationship is to be defined. This solution does not contribute to a corporate set of services.
3. The architecture in scenario 3 is dependent on computing platform. It can be used if the solutions domain or solution architecture is based on this type of integration (e.g. when we buy solutions with a predefined architecture.) and there are clear interfaces and responsibilities.
4. The architecture in scenario 4 is not allowed in Statoil. Same data shall be synchronised across different databases.
5. The architecture in scenario 5 with direct database links between database instances is in general not allowed in Statoil. Deviations might be given for specific solution domains.

Components might be information system, application or integration solutions.

Information architecture requirements

- Solutions must be aligned with existing information architecture. Ref [LINK](#)
- The information maintained by a solution should be possible to access independent of the software, either through an API or through export of the data.
- Solutions should have necessary data management functionalities like maintaining standards, information quality, information life cycle (ILC), information analysis on the system content (e.g. statistics, dashboards etc), and ensure information integrity, security, usage etc.
- Solutions shall utilise corporate master data.

Distribution of data should follow best practice document for information distribution principles ([LINK](#) – preliminary link)

2.6 Business Intelligence

For business intelligence we have the following requirements:

- Transactional data are extracted from the source systems and loaded into the relevant data warehouse (DW). Data should be extracted and transformed only once.
- Reporting /analysis need, requiring data from more than one of the physical DW's should be resolved in an aggregated DW.
- Data should only flow from local data warehouses to corporate data warehouses. Data is not allowed to flow from corporate data warehouses to local data warehouses or between local data warehouses.

Best practices for business intelligence are outlined in Appendix D.

3 Additional information

3.1 Definitions and abbreviations

Application: Software that are used to provide end user functionality. Term used to both describe information systems and also software systems that do not provide data storage. Examples of the typical applications that do not contain data are Office products such as Word and PowerPoint.

Application framework: A software framework used by software developers to implement the standard structure of an application for a specific development environment (such as an operating system or a web application).

Application platform: Software that are used to provide end user functionality. Term used to both describe information systems and also software systems that do not provide data storage. Examples of the typical applications that do not contain data are Office products such as Word and PowerPoint.

Business Intelligence: A set of technologies used to collect, aggregate, and group data for decision support, reporting, analysis, and business simulation and planning. The term includes data warehouse.

Capability: A business functionality that a composition, information system, or application provides. A capability is often implemented as a service.

Compositions: Techniques used to consume services from information systems or applications to form an aggregated user experience or service.

Computing platform: A computing platform includes some sort of hardware architecture and a software framework (including application frameworks), where the combination allows software, particularly application software, to run. Typical platforms include a computer's architecture, operating system, programming languages and related user interface (run-time system libraries or graphical user interface).

Data Warehouse: An integrated, centralised decision support database and the related software programs used to collect, cleanse, transform and store data from a variety of operational sources to support business intelligence.

Data Store: A permanent storehouse of data. The term is often used to lump the storage of all types of data structures (files, databases, text documents, etc.) into one generic category

Information System: Software deployed for production support one or more business processes. It is a placeholder of data and business rules that provides services.

Portfolio: A bounded collection of information systems and functionality that supports defined business area. Business processes are mapped to capabilities, and capabilities are in general defined as services.

Technological Platform: A set of software tools and technologies that are made to form an environment to develop and execute applications. Examples are Java SE, Microsoft .NET, LAMP, SAP Technology Platform.

3.2 Changes from previous version

A link to the Information Technology Network Portal is included in chapter 2.1.1.

Requirement for product, solution or components in life cycle status "Freeze" is changed to include a reference to an approved deviation permit in DISP.

3.3 References

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<http://spap.statoil.com/sites/imterms/Wiki%20Pages/Home.aspx>

[SSAE16]: <http://ssae16.com/>

App A Service Oriented Architecture

Statoil prefers applications and information systems based on the main principles of a Service Oriented Architecture (SOA):

Boundaries are explicit. A boundary represents the border between the public interface and its internal implementation. Services interact through message-passing over well-defined interfaces.

Services are autonomous. Services are entities that are independently deployed, versioned and managed. The keys to realising autonomous services are isolation and decoupling.

Services share schema and contract, not class. Service consumers will rely upon the service's contract to interact with the service. Given this reliance, a service's contract must remain stable over time.

Service compatibility is based upon policy. A service defines a policy that states the requirements with respect to security, transactions and reliability.

Statoil prefers applications and information systems based on object oriented principles (encapsulation, maximise cohesion, minimise coupling) and well known patterns for subsystem design and development.

Technical guidelines:

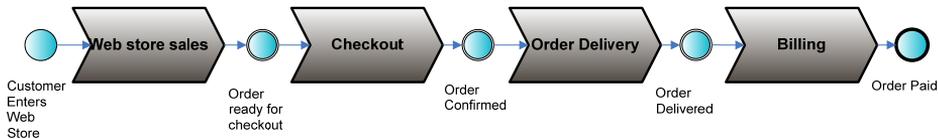
- 1) Integrations between applications should be based on Web Services and XML or message based technology. Web Services should be compliant to the profiles defined by Web Services Interoperability Group (WS-I.org).
- 2) Interfaces should be exposed as services (publish-subscribe and request-reply).
- 3) Integration between applications from inside and outside of Statoil should be based on Internet standards (Web Services and XML) or file transfer.
- 4) Transformations and management of one-to-many and may-to-many integrations should be created using an EAI product.

App B Solution Adherence to Business Boundaries

Developing and maintaining business agility is an important capability to support in applications and information systems. The software that Statoil acquires or implements should support the development and maintenance of an agile business. One aspect of achieving this is to ensure that our software architecture adheres to the business boundaries, so that changes due to business development can be incorporated into the software architecture with minimum effort.

B.1 Determining the business boundaries

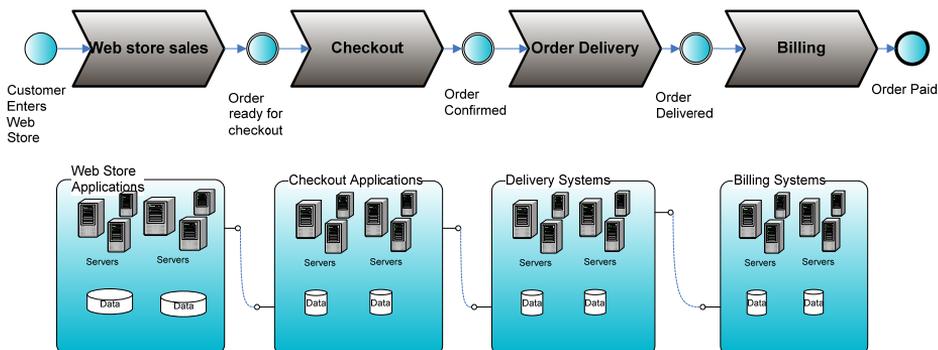
In Appendix A and B of TR0002, short guidelines for determining business boundaries are outlined. A business boundary is a business event that represents natural legal, organisational, operational or physical state changes within the enterprise (from TR0002). These events are then used as boundary or contract between two dependent processes, and processes are bounded to achieve high cohesion and low coupling.



The figure above shows an example of how an order-to-cash process could be separated by natural business boundaries. This separation enables business agility by defining clear contracts between the different processes, thus allowing for development of the different processes, their execution and tool support without undue influence on the neighbouring process.

B.2 Software adherence to business boundaries

To ensure software support for agile business development, it is important that the software does not cross business boundaries without clear interfaces that can be used as entry or exit points for business development, as shown below



If any application is used in more than one business process (as is often the case) and crosses a business boundary, then the application must provide a well-defined, stable interface that other applications can use to hook into the application where appropriate.

B.3 Information adherence to business boundaries

Whenever possible, the information model must include the necessary attributes to support business agility, thus provide the mechanism for possibly splitting the information according to new business boundaries.

App C Business Intelligence

“Data Warehouse” is defined as technology used to consolidate, aggregate, collect or group data into a central repository for decision support, reporting, analysis, and business simulation and planning.

Statoil has a corporate data warehouse instance (CDW) used for strategic reporting.

C.1 Business Intelligence Strategy

Reporting types are often divided into the three categories of ‘operational reporting’, ‘tactical reporting’ and ‘strategic reporting’:

Operational reporting is the type of listings, summaries, balances, etc. business users require for their day-to-day work within an Information System. Such tasks demand near-to-real-time information and hence typically supported by the operational/transactional (‘source’) systems.

Tactical reporting is information processing where users are checking their business on an ad-hoc basis. Examples are weekly management reporting, online analytical processing and data mining. Information from more than one source is often required. This could be achieved within an Information System or created as a new information system, typically, but not always, using data warehouse technology; a Corporate Data Warehouse (preferred) or a Local Data Warehouse (LDW).

Strategic reporting includes management and executive reporting, usually on data collected from several sources, and refreshed periodically. The main rule for this is to create a new Information System. Preferably uses the corporate data warehouse (CDW).

It should be noted that reporting includes all types of information extraction, both manual and automatic. Thus the rules above also apply to internal or external applications.

Near-to-real-time reporting on information across operational systems is, by default, defined as operational reporting. It could however be beneficial to use the corporate data warehouse for this type of reporting, depending on the DW technology and the reporting requirements. (The DW must be capable of handling ‘real-time’ extraction of data from the source systems.)

C.2 The Data Flow

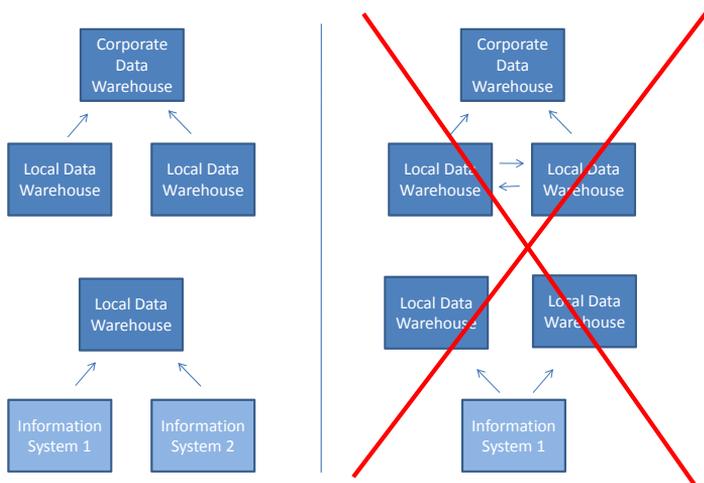
The data flow, from source information systems into strategic reporting information systems should follow strictly defined rules, to maintain consistency and reduce the overall complexity.

A distinction is made between master data and transactional data:
Ideally all information systems share all relevant master data with the strategic reporting information systems.

Transactional data is extracted from the source systems and into the relevant DW component. Data should be extracted and transformed just once.

Reporting /analysis need, requiring data from more than one of the physical DW's should be resolved in an aggregated DW.

Valid and invalid data flows for transactional data are shown in the figure below:



Applied data flow rules:

- One and the same data should only be extracted from the source system into a single DW.
- In a reporting context, data should only flow from LDW's to CDW, not the opposite way, nor between LDW's.

App D Classifying solutions for customisation effort

When assessing a solution portfolio for areas of custom development, we categorise the portfolio in accordance with its role in the enterprise. We use the same categorisation as the corporate technology strategy in terms of categories and the effort we put into solution portfolios within each category. The categories are:

- **Distinct Solutions:** These are solutions that give Statoil a significant competitive advantage and potential for future growth. The solutions support the distinct areas of the corporate technology strategy and/or significant corporate strategic efforts. For these solutions we strive to be innovators or early adopters and are willing to develop solutions especially for Statoil if required by the business to increase competitive advantage.
- **Core Solutions:** These are solutions that maintain Statoil's overall competitiveness. The solutions support key areas of Statoil's value chain processes and/or key areas of the corporate strategy. For these solutions we aim to be early majority and are willing to develop software especially for Statoil if solutions are not available in the market.
- **Basis Solutions:** These are solutions that are necessary to support Statoil's operation. The solutions support Statoil's support processes and/or corporate staff and service organisation. For these solutions we follow market standards and best practices as the late majority.
- **Emerging Solutions:** These are solutions that support new business initiatives. They are technologically proven, but may still be immature. They will often form the basis of tomorrow's distinct solutions. For these solutions we follow the corporate technology strategy and emerging business needs. We are willing to develop solution prototypes especially for Statoil if required by research and development efforts.

Solutions that are developed for innovators and early adopters do not always survive in the long run. Thus, the risks associated with being an innovator or early adopter must be managed to ensure that the impact of discontinued solution availability is understood.

Within each process area, there will be solutions in each of the categories above. Even for the value chain processes, there will be solutions that are considered basis solutions and are managed accordingly. For large solutions, the individual solution components may be classified into several categories. An example of this is the SAP solution, where the SAP Operations and Maintenance solution is considered a core solution, but SAP HR and SAP Finance and Control are considered to be basis solutions.

For more information on adoption rates, see http://en.wikipedia.org/wiki/Diffusion_of_innovations

App E Classifying customisations vs. configurations

These are the definitions of configuration, customisation and custom development in Statoil

- **Configuration** is defined as all non-development changes done to a component/solution, such as master data setup, simple screen setup and business rules entry. In general configurations are initially done through a graphical user interface by a domain expert, but should be scripted by a developer to ensure consistency when the configuration is moved through staging areas and for life cycle management of the configuration.
- **Customisation** is defined as all development changes done to a component/solution such as data model changes, additions of custom code, implementations of complex business rules.
- **Custom development** is defined as the development of components/solutions independent of and on top of solutions that can be purchased in the market.

The life cycle cost of a customisation is estimated by Gartner research to exceed 5 times the initial development cost in maintenance and upgrades. Thus, a 1 MNOK customisation for a solution that is expected to live for 10 years, means a 5 MNOK total life cycle cost that must be covered throughout the life of the system at an average of 500 KNOK per year.

App F Attaining solution quality in software solutions

To achieve an acceptable solution quality in Software Solutions, the following elements should be understood and valued by all teams building SW solutions.

F.1 Technical Debt

Technical debt is defined as the obligations an organisation incurs when it chooses a concept, design or construction approach that is convenient in the short term but increases complexity and cost in the long term.

Technical debt can be intentional i.e. the result from choosing a shorter path than ideally preferred or unintentional as the result from doing a poor job, technically, contractually or management wise. Technical Debt can be short or long term. Typically short term debt comes from shortcuts made to reach a type of milestone. Often the intention is to remove the shortcut later in the current development effort. Long term debt comes from decisions made at a given point, which will not be valid in the future.

F.1.1 Technical debt management

Technical debt management depends on a holistic solution lifecycle process / system view. Technical debt may be managed and/or measured. The short term technical debt can be managed in the same way as application attributes (non-functional requirements) are managed.

F.1.1.1 Metrics

It is possible to monitor the influence of technical debt on software applications by some metrics:

- A simple metrics is to correlate a product teams time spent on value demand (implementing new business functionality) over failure demand (fixing bugs introduced by previous value demands).
- Another indicator might be found in a development team's velocity i.e. the speed they solve backlog items

F.1.2 Instructions to minimize technical debt

It is an overall goal to reduce the technical debt to a minimum, hence the following instruction apply:

- It is not acceptable to allow intentional short term technical debt to grow into long term debt. This means that intentional shortcuts made through development efforts, does not allow growing into long term debt across the timing of the development effort.
- It is recommended to manage intentional short term as new attributes of the application. Document all shortcuts as new attributes and put them into the list of prioritized requirements which must be undertaken by the team in future releases.

Long term technical debt should be minimized by continuously monitor technology shifts, and gradually remove debt by using proper technologies in the product. Typically this is achievable when products are maintained through a holistic Product Life Cycle management.

F.2 Quality of Code

To ensure proper Code quality during development projects or product management work, it is recommended that Definition of Done Criteria's are defined for the work done. The criteria may be elaborated and agreed upon by the development effort. Typically the following factors are discussed:

-
- Create Clean Code by proper refactor code into sustainable quality for further change and maintenance.
 - Pair Reviews. All code of importance, like business logic, legal algorithms etc. should be reviewed by other team members.
 - Pair Coding. At least difficult algorithms or design patterns should be considered coded by pairs.
 - Unit Test Coverage:
All code of importance like business logic, domain model, interfaces should be covered by automated unit tests.
 - Functional Test:
Functional tests cover combinations of code performing a function typically using test techniques such as specification based testing, boundary value analysis, etc. As it is not possible to test an entire system, a risk based approach to testing should be used to focus functional testing towards the key areas of the system. Both manual and automated functional tests must be maintained in a in a controlled manner to gradually build up a regression test suite used for the life cycle of the system under test. Manual tests are typically maintained in an ALM test management tool. It is preferable to automate functional tests, typically by using a test framework (e.g. Fitnesse, RoboFramework). Consider automating tests that are often repeated, and let the time saving drive the automation.
 - Acceptance test:
The purpose is to verify that functionality is working as expected and in accordance with the requirements for change and performed by business users. The acceptance test should be documented and sign off obtained from the business.

A good, well defined and understood test process including early reviews and design improvement will contribute to preventing errors. It should be regarded as good practice to begin testing at the requirements stage to root out misunderstandings, abnormalities and plan for how the system will be tested.

To change a piece of software without a successful test run validating a correct change is regarded as bad practice.

F.3 Automated Build

Change is the future. To enable rapid change the build process must be automated. The code should be built directly from the version control system, and feedback to the team members (and others) must be easily available. The automated build must be followed by execution of all unit tests, and automated functional tests. Automation of the build and test enables the team to build trust in the solution, and becomes a fundament for rapidly changes on the application.

F.4 High Deployment Rate

Solution quality is dependent on continuous feedback from end users. Changes to the application should be put into production as fast as possible. Changes not implemented in business do not give value to the business nor to the development team as valuable feedback on the developed features. High deployment rate is also risk reducing, since fewer changes are deployed at the same time, and it is simpler to keep the overview of all changes in the deployment.

F.4.1 Design smaller independent deployable applications or modules

To increase or keep a high deployment rate, smaller separately deployable applications is needed. Too large systems or systems with tight couplings to others– will slow down the possibility to keep a proper deployment rate.

F.5 Automated Operation

To simplify operations of a solution the solution should be instrumented for monitoring and automated operations where the solutions operational state is visible.

App G HSE-Critical IT Systems

HSE-Critical Systems should be treated separately. Safety critical systems in context of Automation are regulated by TR3031.

Software should be assessed for its criticality pursuant to this definition; HSE-Critical Systems are systems that by failing directly or indirectly may

- Result in loss of human life or lasting injury
- Result in environmental demolition

The criticality of the Software assessed should be concluded during Architecture Contract.

Software that is classified as HSE-Critical may be handled according to the standards ISO IEC 61508 and/or DO-178B/C & DO-254. Certification of the SW may be considered. Such solutions may be secured using IT technology.

Uncertainty in the evaluation of any requirements or guidelines must be assessed by the Process Owner IT. Other relevant Process Owners will be involved.

However it is extremely unlikely for enterprise systems, communications and other systems that do not deal with protection of life are HSE-critical.