Developing a project architecture and evaluating the Enterprise Architecture initiative at Tata Steel

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THESIS

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by

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Abstract

Organizations have become more aware of Enterprise Architecture and the need to work under architecture. Tata Steel assumes that Enterprise Architecture can help them realizing the benefits that come from working with Enterprise Architecture as presented in literature.

This thesis consists out of two parts. The first part is about the process of developing a business and application architecture, and the development of the architecture itself. An 'as-is' project architecture, which represents the system landscape and business processes at the start of the project, and a 'to-be' project architecture, which represents how the system landscape and business processes should look when the project finishes, was developed. The goal of the project for which the architecture was developed is to change the system landscape in such a way that it can support the newly developed distribution model.

The second part of the thesis focuses on research questions about Enterprise Architecture. The most important goal of this thesis is to describe how Enterprise Architecture can be implemented in an organization like Tata Steel. The Enterprise Architecture approach that Tata has chosen is described, evaluated and improvements are suggested. The governance of architectural models is discussed and the value of architecture is discussed. All while using the experience gotten from creating the 'as-is' and 'to-be' project architectures.

Keywords: Enterprise Architecture, ArchiMate, TOGAF, Project architecture

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Part I
Context

1. Introduction

This thesis is the result of my internship at Tata Steel IJmuiden. Tata Steel is a company which produces around 7.5 million tons of steel annually. The goal of this thesis is to describe how to implement Enterprise Architecture (EA) in an organization like Tata Steel. During the internship a project architecture is developed, using the architecture modelling language ArchiMate.

The architecture to be developed is a business- and application architecture for a project for the department Logistics and Transport which changes the system landscape and business processes in such a way that it fully supports a new distribution concept. This new distribution concept was developed to allow further growth of production to 8 million tons of steel a year.

The experience obtained and observations made during development of the project architecture, along with further research into the EA initiative at Tata steel, are used to answer research questions which contribute to describing how to implement an EA initiative in an organization like Tata.

1.1. Background and motivation

Former architecture approaches have proved unable to realize the benefits which should come from working under architecture. Enterprise Architecture is considered to be the solution which should be able to realize the benefits promised in literature. This thesis describes how EA can be implemented in an organization like Tata.

Literature sources provide loads of information regarding Enterprise Architecture. This thesis differs from the majority by taking a more down to earth, and hands on approach from a practical viewpoint. It investigates how to implement an EA initiative within an organization and tries to come up with answers to some EA specific challenges which an organization is likely to encounter.

To become familiar with the EA initiative at Tata Steel, and to gain experience in modelling with the ArchiMate language, a project architecture is developed. In order to get sufficiently familiar with the EA initiative at Tata Steel, and to be able to thoroughly evaluate the initiative from a hands on experience a project of significant size and complexity is chosen.

1.2. Problem definition and goal

The goal of this thesis is to show how EA can be implemented in an organization like Tata. This goal can be reached by evaluating the EA initiative at Tata and helping them to improve it which is extra challenging considering the industrial character of the organization.

Another goal of this thesis is to develop a project architecture. In order to allow Tata Steel to grow to a production of 8 million tons of steel a year a new distribution concept is developed which isn't supported by the current business processes and application landscape. Architectures are developed for a complex project called ONDL Basis (ONDL). In English ONDL stands for Optimization Network Distribution Logistics.

The architectures developed can be used to guide the design and implementation of changes to the business processes and application landscape in order to support the new distribution concept. After the architectures are validated by subject matter experts, interviews will be held to assess the value of working with architecture.

The last goal of this thesis is to become a valuable document for anyone who is interested in the field of Enterprise Architecture. This thesis tries to reach all goals by first describing and

evaluating the process of developing architecture. After that the focus is put on the challenges that Tata, and organizations like Tata, face regarding an EA initiative.

Although most research questions may seem to be focused on Tata the answers aim to not only help Tata but all organizations that face the same or similar challenges. In order to investigate how to implement EA in an organization, the EA approach at Tata is described and evaluated.

- Which approach has Tata chosen to work with Enterprise Architecture? Is this approach already completely defined? What can be improved?

- Up to which level of detail has Tata chosen to model using ArchiMate and at which point do they switch to other, for example not Enterprise Architecture related, techniques? Up to what level should an organization model?

- Is the subset of ArchiMate as specified in the "Tata Steel in Europe ArchiMate Meta model" sufficiently extensive to create the architectures for this project? Should an organization use an ArchiMate Meta model?

- How should governance of architectural models be organized?

- Is the existing high level business description, referred to as 'thin-layer' suitable as a steppingstone for the architectures created within the ONDL project? Should an organization have an architecture that can be used as steppingstone?

- Is the 'to-be' project architecture of the ONDL project compliant to the layer model as is standard within Tata?

- Tata Steel is an organization with its core business in producing steel. What observations can be done regarding working with Enterprise Architecture in such an industrial organization? Are there specific ways in which the architecture approach needs to be customized?

- What are the advantages and disadvantages of working under architecture within the ONDL project?

1.3. Social and scientific relevance

Each thesis should have some sort of relevance. Without its relevance this thesis serves no purpose. This section describes why achieving the desired goals of this thesis is of value to its readers.

Enterprise Architecture aims to bridge the gap between business and ICT. Enterprise Architecture is a relatively young discipline and its added value still needs to be proved. With regard to the current worldwide economic situation investigating a subject area which should ultimately deliver an organization more value for each euro invested in IT seems a justifiable cause.

This thesis is intended for those interested in the field of Enterprise Architecture. And especially for those who wish to start an Enterprise Architecture initiative at their own organizations or those who are interested in developing project architecture. This thesis assumes that the reader knows ArchiMate [2], the Enterprise Architecture modelling language, and is able to read architectures developed.

The process of developing project architectures and the experiences which come from the development of those architectures are described. Other architects can profit from this. This thesis further more discusses the Enterprise Architecture initiative of Tata. The most important aspects like for example the benefits, the approach, and governance mechanism are evaluated

and discussed. All contributing to describing how organizations like Tata could start their own EA initiatives.

1.4. Structure of this document

This thesis document is structured in three parts. The first part is about the context in which the thesis is conducted. The first chapter, this chapter, is an introduction to the thesis. Chapter 2 is about Tata Steel. It shows amongst others where Tata Steel fits in the Tata Group, and briefly shows how steel is produced. It provides the reader with some contextual information which is required to understand part 2 of the thesis.

Part 2 is about the Business and Application architectures which will be developed within the ONDL Basis project. Chapter 3 introduces the ONDL Basis project. It describes developments supporting ONDL, the project goals, and explains which parts of the system landscape ONDL will affect. Chapter 4, titled developing business and application architecture, starts with methodology and tooling. It then discusses the approach and then the architectures itself. The chapter ends with describing how the architectures are validated. Some conclusions and observations regarding the project architecture and methodology are mentioned here.

This thesis will also be of value to whoever is interested in the field of Enterprise Architecture. Architects could profit from the lessons learned, and the approach to develop project architecture described in this part.

Part 3 is about Enterprise Architecture at Tata Steel. In this part the focus is put on the EA initiative. Experiences, observations, and conclusions from part 2, along with additional research into the EA initiative at Tata Steel, are used to answer the research questions, formulated in section 1.2, in Chapter 5. Chapter 6 draws conclusions and describes future work.

This part which describes the EA initiative at Tata and answers the research questions can be beneficial to organizations who want to set up EA or those who face the same challenges as Tata does. Although some conclusions are based upon a single case study some generic results come forward.

2. Tata Steel

This chapter is about the company at which this thesis was conducted: Tata Steel in IJmuiden. It starts with a paragraph on the Tata Group of which Tata Steel forms a part. Then a paragraph on Tata Steel location IJmuiden, followed with a small sidestep explaining the steel making process and most important installations on site at a high level. After that the Tata end to end processes, 9 important high level processes, are discussed. This chapter will provide contextual information required to understand the rest of the thesis.

2.1. Tata Group
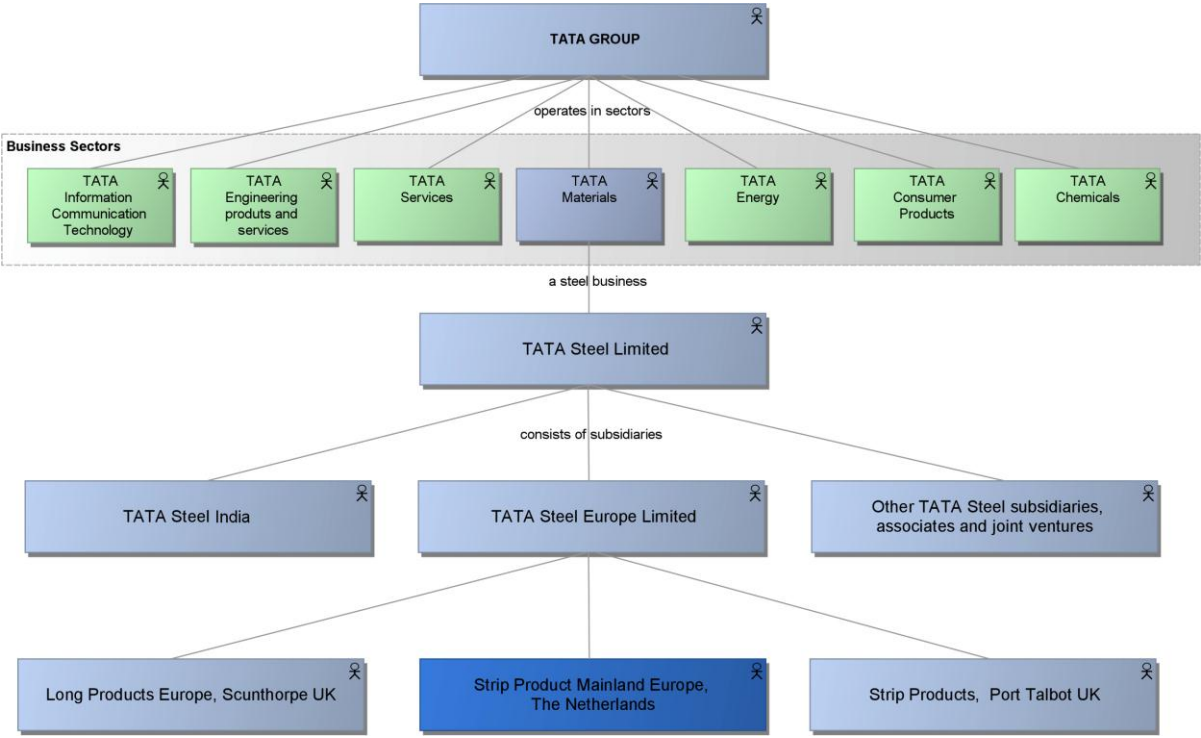
Figure 1, Tata Group

Tata Steel is a part of the Tata Group. The Tata Group [4] operates in a wide range of sectors. Some examples are the Taj Hotels, Tata Global Beverages, the second largest tea company in the world, and, Tata Motors, including brands like Jaguar and Land Rover. The Tata Group has establishments in over 80 countries. In the year 2009 - 2010 the total income was 68 billion euro. Figure 1 shows the Tata Group and to which part of the complete organization Tata Steel in IJmuiden is connected.

Tata Steel [5] is part of Tata Materials, which is divided in Tata Steel Thailand, Tata Steel India, Tata Steel in Europe, and other Tata Steel subsidiaries, associates and joint ventures.

Tata Steel in IJmuiden is part of Strip Products Mainland Europe, which in its turn is part of Tata Steel in Europe. The headquarters of the Tata Group and Tata Steel is located in India.

2.2. Tata Steel in IJmuiden

Tata Steel in IJmuiden produces around 7.5 million tons of steel a year. It is the biggest production site of Tata Steel in Europe, has over 9300 employees and equals the size of the municipality of Bussum.

The site produces high-quality cold rolled, hot rolled, and coated (painted or tinned) steel. IJmuiden produces mainly for customers in three different markets:

1. Automotive industry

2. Construction

3. Packaging steel

The site, shown in the figure below, has an unique advantage over many other production sites as it has its own deep-sea harbour. Besides the deep-sea harbour which allows stock to be transported with sea ships stock can also be transported using cargo trains, trucks, and or inland vessels.

Figure 2, Tata Steel in IJmuiden

2.3. Steel making process

This paragraph gives a high level overview of the steel making process as executed at Tata Steel in IJmuiden. Although this can be considered to be a sidestep everything depends completely on the production of steel. It might be nice for those interested to know more about the steel making process and it most important installations.

To produce steel the following raw materials are needed: Coal, ore, and additives. Before these materials can be used in the blast furnace to produce pig iron they need to be processed first.

Coal is processed in the coke-oven plant and comes out as coke. Ore and additives are processed by either the sinter plant to sinter or the pellet plant to pellets.

A combination of coke, sinter, and pellets is entered to the blast furnace which then produces pig iron. The gasses which are generated in this process are transferred to an energy plant nearby. The chemical process which takes place in the blast furnace is shown below. Removing oxide from a substance, in this case iron (III) oxide using carbon monoxide is called reduction.

iron (III) oxide   +   carbon monoxide   ➜   *iron   +   carbon dioxide*

$$Fe_2O_3(s) \quad + \quad 3\ CO(g) \quad \rightarrow \quad 2\ Fe(l) \quad + \quad 3\ CO_2(g)$$
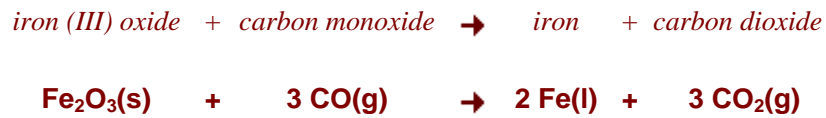
The next step is the basic oxygen steel plant. It uses oxygen on the pig iron to reduce the carbon content in the pig iron. This results in steel. The steel produced in the basic oxygen steel plant can be processed further in two ways. It is either transported to the direct sheet plant (DSP) which transforms the steel directly into coils or to the slab casting machine which transforms the liquid steel into slabs. In both cases the coils or slabs can be further processed or sold to customers.

Raw material - Pig iron - Making steel - Casting - Rolling - Coating
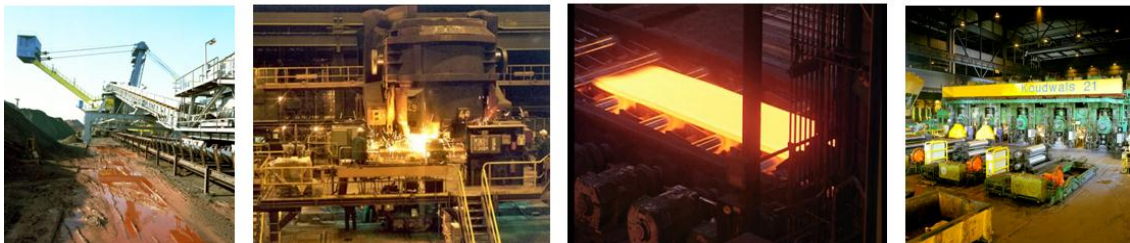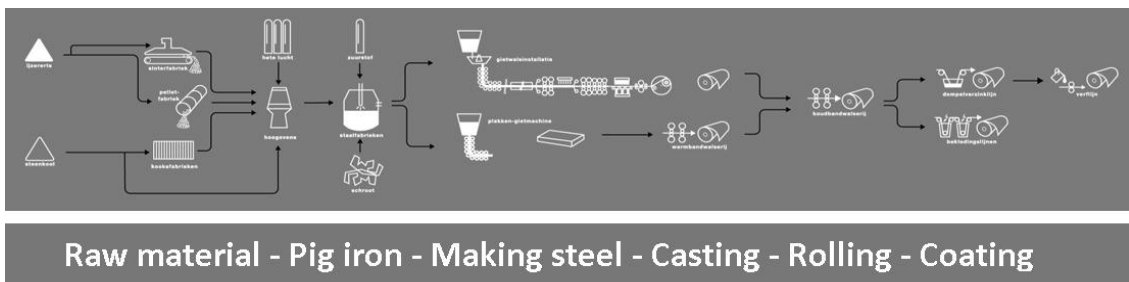
Figure 3, Steel making process [1]

The slabs can be further processed by the hot strip mill into coils. Coils can be processed in the pickling line, cold strip mill, galvanising line, and or painting line. In general Tata in IJmuiden aims to apply as much additional operations to the steel as possible, the profit margin in general increases with each operation.

2.4. Tata Steel end to end processes

Tata Steel has defined nine high level end to end processes. This section describes those end to end processes and shows which one or which ones are affected by the ONDL project. The ONDL project, for which a business and application architecture will be created, will be explained into detail in the next chapter.

Figure 4, End to end processes

The end to end processes are already modelled in Enterprise Architecture modelling language ArchiMate [2]. This is done in the so called 'thin layer'. The goal of this layer is to provide insight in the organisations processes at the highest possible abstraction level. And, at least as important, to function as a steppingstone for project architectures to connect to.

Checking where and if the created architecture can be connected to the 'thin layer' answers one of the research questions:

- Is the existing high level business description, referred to as 'thin-layer' suitable as a steppingstone for the architectures created within the ONDL project? Should an organization have an architecture that can be used as steppingstone?

ONDL affects the customer to cash process. The other eight processes are not or insignificantly affected.

2.5. Tata Steel project approach

This paragraph explains how projects are managed at Tata Steel. The project approach is described in order to provide the reader of this thesis with required background knowledge to understand the link between the project approach and architecture deliverables.

The project management office has a roadmap with a scope of 1-3 years. This roadmap shows the objectives which are to be achieved through execution of projects. A steering committee business information systems IJmuiden currently determines the priority in objectives and thus projects. Besides the roadmap there is a rolling forecast with a scope of 3 to 6 months which contains the projects in execution.

Tata has adopted Prince2 [11], a structured method for project management. Prince 2 helps and structures the management, control, and organisation of a project. A project consists out of three phases: study phase, initiation phase, and realisation phase.

Before a project is started someone has an idea or wish. This idea is then transformed into a project a4. This is literally one a4 which explains the business case, has a global planning, and explains the impact on the business processes. The project a4 also comes up with a cost estimate. Under the assumption that the project will be executed the cost estimation should prove to be within a 50% accuracy margin.

In the study phase the way of working is described. This document explains the current or 'as-is' and future or 'to-be' situation. This document is used as input for the project letter which is produced after validation of the way of working. The project letter describes the plan for the initiation phase. Another cost estimate is made. This estimate should prove to be within a 25% accuracy margin. The project a4, also used for communication with higher management, is updated.

In the initiation phase the global functional design is produced. This document explains how the system landscape and business processes will change. This document is used as input for the project initiation document which is produced after validation of the global functional design. Another cost estimate is made. This estimate should prove to be within a 10% accuracy margin. The project a4, also used for communication with higher management, is updated again.

In the realisation phase the functional design and technical design is produced. After validation the build starts and testing follows. The project management cycle finishes with release.

Part II
Business and Application Architectures for ONDL Basis

3. ONDL Basis

Chapter 3 is about the project ONDL Basis (ONDL), for which a business and application architecture will be developed. ONDL is about implementing a new distribution concept which is required to allow growth of the production capacity at Tata Steel in IJmuiden to 8 million tons a year. ONDL stands for Optimization Network Distribution and Logistics. The first paragraph introduces the project and explains why changes to the system landscape are required. The second paragraph describes four developments supporting ONDL. After that a paragraph is dedicated to describing project goals. The chapter concludes with a paragraph about ONDL in the system landscape. It indicates what parts ONDL will apply changes to. The goal of this chapter is to provide the reader with background knowledge on the project for which architecture is developed.

3.1. Introduction to ONDL Basis

In the future the department Logistics and Transport (LT) expects to make significantly more use of the external distribution network. This expectation is based on a study conducted in July 2008: "Effects of growth to 8 million tons of steel on the distribution model of IJmuiden". The current systems can't handle this new distribution model and therefore need to be changed.

The new distribution model aims at storing stock as close to the customer as possible. The most important reason to do so is a lack of conditioned storage space in IJmuiden. Besides that the new distribution model should also contribute to providing higher service levels to customers, reducing overall transportation costs, and achieving environmental goals like reduction of finedust.

3.2. Developments supporting ONDL

The future vision, in which stock that is ready for sending is moved off the site and to storage as close to the customer as possible, is driven by the following aspects:

1. Lack of conditioned storage space in IJmuiden

Because of the growth in production of pickled and coated stock, the need for conditioned storage increases. Because of the technical state of one of the dated storage halls the chance of disturbances or even a reduction in conditioned storage capacity lurks. Production can't be disrupted by a lack of storage capacity. Therefore a flexible buffer between production and the delivery date, as requested by the customer, is required. This buffer can be realized through usage of external warehouses (junctions).

2. Customers requiring higher service levels

Customers of Tata Steel require extra service, or will be more satisfied if more service is provided. For example unwrapping of stock, or returning the packing material. All of those extra services can be better provided locally. Customers want to follow their orders so tracking and tracing is another requirement which the current system landscape doesn't support.

3. Increasing environmental pressure on site IJmuiden

The current modality mix is under pressure because of cost developments, like fuel surcharges, taxes, and availability issues, like lack of truck drivers and lack of wagons. Another important aspect comes from the province Noord-Holland which requires IJmuiden to reduce traffic congestion. Using junctions can help solving this problem because if the customer wants to be delivered by truck, the stock still can leave IJmuiden by another modality like train or ship.

4. Change of market (geographical)

Transports over big distances to far away destinations are very costly when done by truck. Taking more time and using other modality in combination with nodes have a potential of saving a lot of money.

3.3. Project goal

This section describes the main goal of ONDL Basis. To overcome the problems and developments, as described in the previous paragraph, which prevent the growth of the maximum production capacity to 8 million tons a year, Tata steel aims to store stock, released for transport, as close to the customer as possible.

Storing stock as close to the customer as possible should be realized by the implementing the new distribution concept developed by Tata. Unfortunately the current system landscape isn't suited for this distribution concept. It needs to be changed. The main goal of ONDL basis to adapt the system landscape to the new distribution concept. The project has a number of sub goals.

The first sub goal of the project is to decrease costs of storage & transport per ton of steel. This should be achieved by introducing a fixed schedule for parts of the on-site and external transportation. Environmental goals are decreasing finedust and noise caused by transport. The last goal is to reduce the number of trucks on the site which should increase safety.

3.4. ONDL in the system landscape

This section describes from a top-down viewpoint where the system landscape and business processes will be changed in order to support the new distribution concept. It divides the system landscape into several parts which all are affected by ONDL.

As already mentioned in 2.4 ONDL affects the customer to cash process. Customer to cash starts with establishing the customer. Then process inquiries, quotations and orders. After that production and distribution of goods / services, invoice customer, and finally manage accounts receivable.

The so called 'thin-layer' architecture includes a representation of this end to end business process. The parts that ONDL will apply changes to are highlighted in figure 5. The remainder of this paragraph describes what changes will be applied to the parts that ONDL will apply changes to.

IJmuiden SLD Domain Architecture
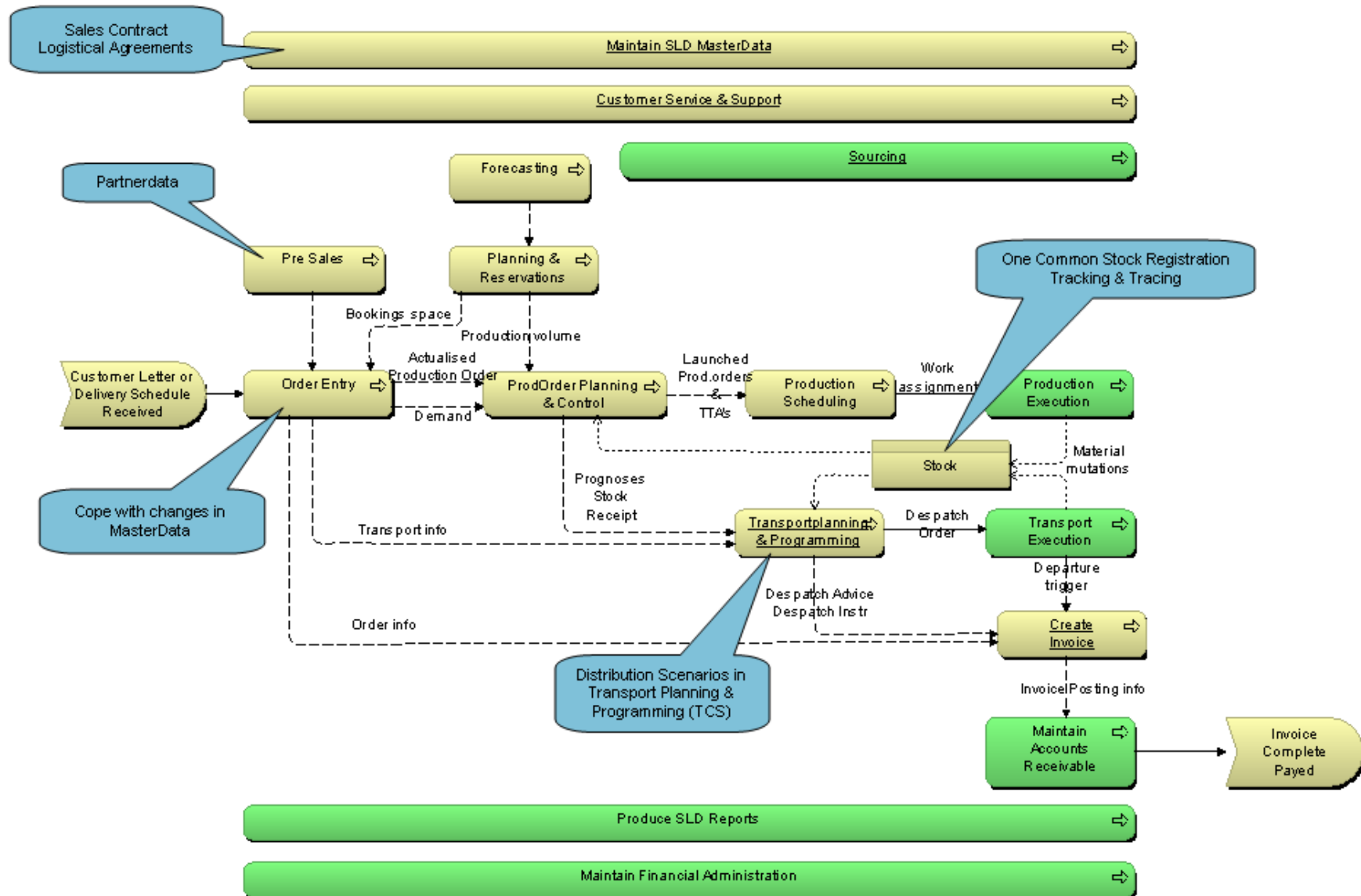
Figure 5, Customer to cash ONDL highlights

Maintain SLD MasterData:

Masterdata is business data from a single source that is used by multiple systems, applications and or processes. The way in which masterdata is managed will be changed. The logistical agreements now part of application component CASH will be taken out and moved to its own application component.

Pre Sales:

Partner data which is stored within the Pre Sales business process will change. Different data will be stored.

Order Entry:

The Order Entry process uses masterdata. As the masterdata itself will be changed, Order Entry will have to change also in order to obtain and process the right masterdata.

Transportplanning & Programming:

The transport planning and programming process will have to be able to deal with the new distribution scenarios.

Stock:

Customers require higher service levels as explained in 3.2. One of these requirements is tracking and tracing of external stock which isn't supported in the 'as-is' situation. One common stock registration should prevent the situation in which for example customs receive documents about cargo which are inconsistent with one another.

4. Developing business and application architecture

Chapter 4 is about the business and application project / solution architectures developed for the ONDL project. It starts in the first paragraph with the tooling used to develop the architectures. Paragraph 4.2 describes the approach and methodology. It begins with guidelines and standards followed, among which the Tata Steel ArchiMate Meta model, and says something about the training course in ArchiMate and Architect that was followed. Then the information sources used to obtain both general and project specific knowledge are listed followed by a deeper look at the project architecture development approach and evaluation of the approach.

The next two paragraphs describe the architectures. An 'as-is' project architecture is developed, describing relevant parts of the current system landscape, and a 'to-be' project architecture, describing how the system landscape should look after the project is completed. This enables the architectures to function as a guidance tool for the design and implementation of changes to the system landscape. Paragraph 4.3 describes, explains, and discusses some parts of the 'as-is' architecture. Paragraph 4.4 does the same for the 'to-be' architecture. Paragraph 4.5 discusses the validation of the architectures and points to validation results. The last paragraph 4.6 in this chapter shows the conclusions which come from developing the project architecture.

The goal of this chapter is to describe how the project architecture is developed, while complying with the standards and guidelines of Tata Steel, and to evaluate the approach to allow other architects to profit and learn from it. Conclusions from this chapter are used in the next chapter along with additional research into the EA initiative at Tata Steel to answer the research questions.

4.1. Tooling

This paragraph describes the tooling used to develop the 'as-is' and 'to-be' architectures. The architectures are modelled in the architecture modelling language ArchiMate [2]. ArchiMate is a graphical modelling language for Enterprise Architecture. ArchiMate, which is a concept of the Open Group [6], enables visualization and communication of architecture. A brief summary of ArchiMate and its relationship to TOGAF can be found in my literature survey [7].

ArchiMate is the standard and most well-known Enterprise Architecture modelling language in the world. Suited alternatives are almost impossible to find. This made the choice for ArchiMate easy as there was, and is, no other option.

The tool used to develop and model the architectures is Bizzdesign Architect [8]. Bizzdesign is a surprisingly Dutch company from Enschede. Bizzdesign Architect is the first tool that fully supporters ArchiMate and facilitates modelling and visualizing Enterprise Architecture. Although alternatives are available, for example the free tool Archi [9], which seems to grow and develop quickly, Bizzdesign Architect seems to be the most comprehensive and mature tool around. Tata had already made a choice for Architect when the internship started. This was not a problem as Architect proved to be suited for the job.

4.2. Approach and methodology

This paragraph describes the approach taken and methodology used to develop the architectures. The first section 4.2.1 describes the guidelines and standards followed. The next section, 4.2.2, describes how general knowledge required to develop the architectures is obtained. Section 4.2.3 describes how project specific knowledge required to develop the

architectures is obtained. 4.2.4 describes how the thesis was guided. The last section 4.2.5 describes how all of this worked out in practice. It explains and discusses the approach.

4.2.1. Guidelines, standards, and training course

The methodology used to develop the architectures is adopted from the Architecture Development Method (ADM) of the Total Open Group Architecture Framework (TOGAF) [7] [10]. The ADM is used as a guideline wherever possible. It isn't followed closely because the ADM is developed for complete Enterprise Architectures and not for project and or solution architectures. In fact mainly the phases in which architectures are developed that can be visualized with ArchiMate are followed.

The most important document to guide and structure the development of the architectures is the Enterprise Architecture Handbook of Tata Steel in Europe (TSiE). The purpose of that document is to "serve as a reference for first time and experienced users of the modelling language ArchiMate, and the tool Bizzdesign Architect.". It gives an overview of ArchiMate and describes how it should be used at Tata.

The EA handbook of TSiE follows guidelines from the Open Group and Bizzdesign which are customized for use within Tata Steel. The document is divided into two sections. One is about ArchiMate, and the other about Bizzdesign Architect.

The ArchiMate section suggests using a limited set of symbols and relations from the ArchiMate language. The selection of symbols and relations are combined into a conceptual framework for working with ArchiMate at TSiE. The framework consists out of 7 layers, just as the standard ArchiMate 7-layer-model. The document then discusses the three main layers, business layer, application layer, and infrastructure layer in more detail. It provides the architect with definitions and naming conventions.

The framework, referred to as TSiE ArchiMate Meta model, is shown in figure 6. The architectures created in this project are as much as possible in compliance with the meta model. Deviations from the standards are discussed and documented. Conclusions regarding the use of this model are described in the last paragraph of this chapter. Paragraph 5.3 discusses the value of an ArchiMate Meta model and comes up with an answer to the corresponding research question:

- Is the subset of ArchiMate as specified in the "Tata Steel in Europe ArchiMate Meta model" sufficiently extensive to create the architectures for this project? Should an organization use an ArchiMate Meta model?

The section about Bizzdesign architect provides the architect with starting points, conventions, and tips and tricks in order to help the architect getting started with the tool and developing architectures in a uniform way.

In order to get acquainted with ArchiMate and Architect a foundation training given by Bizzdesign at Tata [12] was followed. The training course is for those who want to start with ArchiMate and Architect. The course takes two days and afterwards architects should have:

- Overview of modelling language ArchiMate for describing architectures

- Knowledge and skills for the support that Architect provides for the modelling, visualising, and analysing of Enterprise Architecture
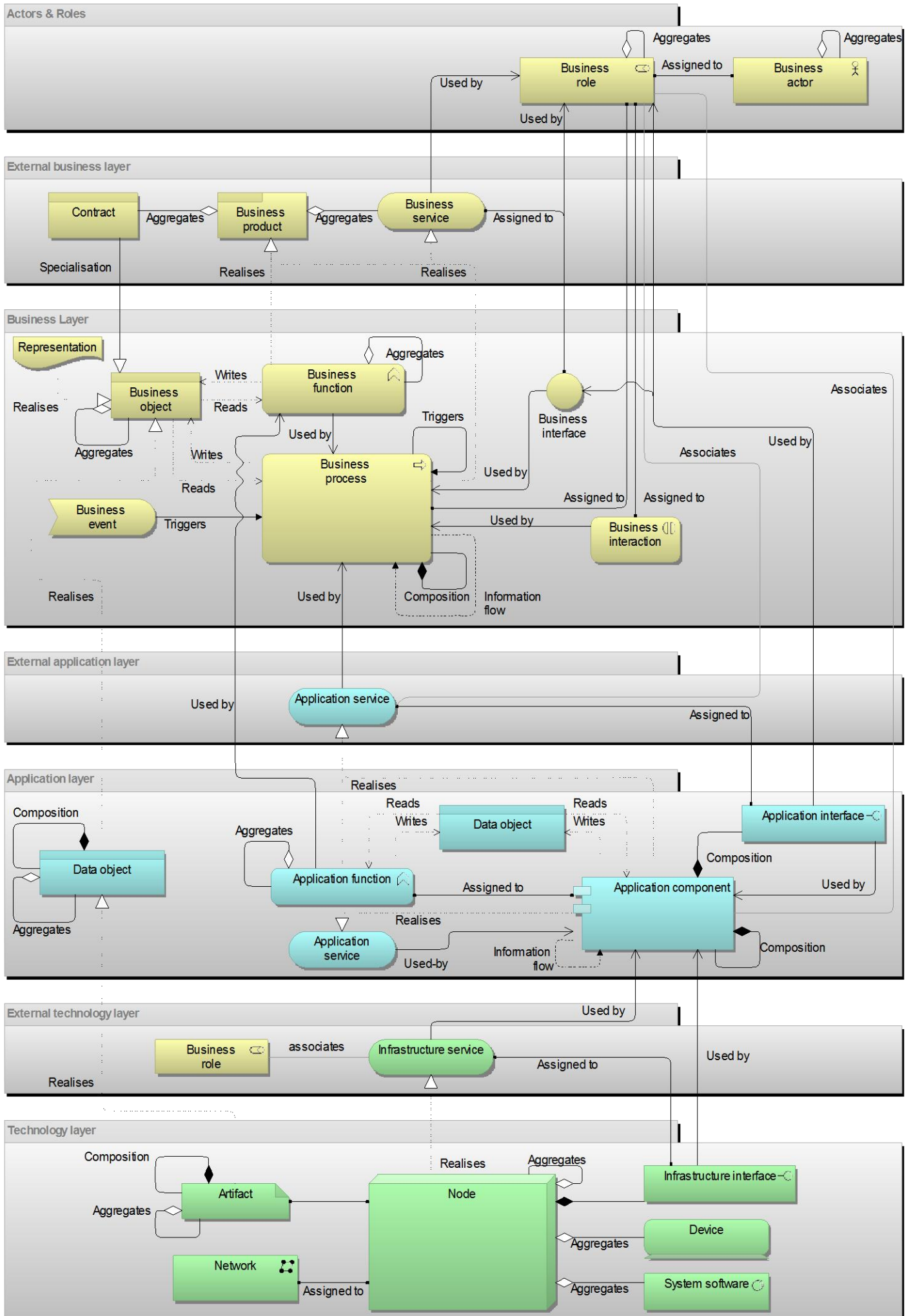
Figure 6, TSiE ArchiMate Meta model

4.2.2. Obtaining knowledge of system landscape

This section describes how the knowledge is obtained that is needed to create the project architectures. The knowledge required can be divided into general knowledge of the organization and its system landscape, and project specific knowledge.

In order to develop the 'as-is' and 'to-be' architecture extensive knowledge is required of the systems and processes that will have to be changed in the ONDL project. In order to properly understand these changes more general knowledge of the subject area also is required. At the start of the project both were missing.

The information used to obtain the general knowledge came from several sources. Before discussing the information sources used to obtain project specific knowledge those used to obtain general knowledge are described:

Business Knowledge Cycle (BKC):

The BKC (Business Knowledge Cycle) is a training that aims to maintain and educate knowledge of relevant business processes within the ICT organisation of Tata. The participants are all employees of the Group Information Services (GIS) organisation; information management; business analysts, programmers, etc.

The training consists of 11 sessions (one afternoon a month). During those sessions a representative of the business explains about a business process. After that an ICT expert highlights the supporting ICT environment. Figure 7 shows the business processes on which the training focuses.
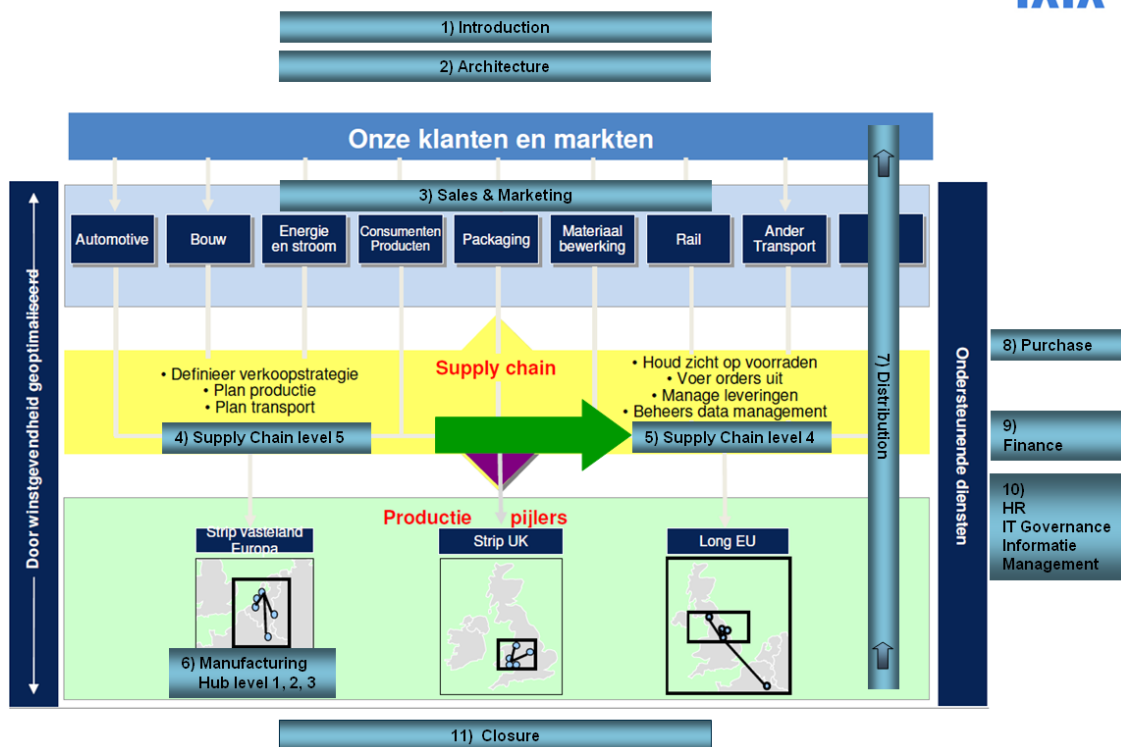
Figure 7, Business Knowledge Cycle

Interviews:

During the internship at Tata a number of interviews were held in which people told about their role, function, expertise, and how things are arranged at Tata. But above all they each provided small or big chunks of information, possibly relevant to ONDL, but for sure relevant in understanding the system landscape and way of working at Tata.

Interviews were held with a project manager, information manager, business consultant, manager Enterprise Architecture, IT architect, consultant of Bizzdesign (EA expert), and several domain experts. Although all provided valuable information, the domain experts were most important because they possess the most knowledge about the system landscape. They also provided other information sources like documents and pictures from which more information could be retrieved.

4.2.3. Obtaining project specific knowledge

This section describes how project specific knowledge is obtained needed to create the 'as-is' and 'to-be' architectures. In order to completely understand the changes that ONDL will have on the system landscape first the knowledge as described in the previous section should have been obtained.

Knowledge about ONDL was obtained from roughly three sources: Interviews with domain experts, way of working, and global functional design. Other chunks of information relevant to ONDL were obtained from the information sources mentioned in the previous section.

Way of working:

The way of working describes the current and future situation. Or 'as-is' and 'to-be'. The document tells in detail what business processes will be changed by the project and why.

Global functional design:

The global functional design describes how the system landscape will change. It describes into detail how the system landscape and business processes will be changed in order to be able to work with the new distribution concept.

Interviews with domain experts:

ONDL is a project which applies changes to a relatively big part of the system landscape. As shown before ONDL applies changes to the end to end process customer to cash. The global functional design specifies which parts of the high level customer to cash process will be changed. Some of the most important parts are masterdata management, order entry, and transport planning and programming as can be seen in the division of the system landscape into parts that are affected by ONDL in paragraph 3.4. In order to get specific knowledge of those parts and to discuss and validate the architecture interviews were held with domain experts on the above mentioned parts.

4.2.4. Project guidance

This thesis was guided by both Tata and the TU Delft. Each 2 weeks a meeting at the TU Delft was organized in which project progress was discussed with fellow students and the guiding professor. At Tata every 2 weeks a session was organised with a project manager and senior designer / architect. In these sessions the overall project progress as well as problems encountered and or resources needed were discussed. Another biweekly session was organised with one or more members of the Enterprise Architecture competence centre, a group of people with experience on the field of Enterprise Architecture. In these sessions discussions were held

about the architectures, the standards within Tata, and the Enterprise Architecture approach of Tata. Whenever needed an ArchiMate and Bizzdesign Architect consultant was consulted for advice regarding modelling techniques and tooling.

4.2.5. Approach and evaluation of approach

This section describes into more detail the approach taken and refers to the previous sections by showing how everything came together.

In order to create the 'as-is' architecture extensive knowledge is required of the systems and processes that will have to be changed in the ONDL project. In order to properly understand these changes more general knowledge of the subject area is required. At the start of the project both were missing. The information sources used to obtain the required knowledge are specified in sections 4.2.2 and 4.2.3.

After enough information was obtained a start was made with modeling a high level view on the customer to cash process which was deducted from the interviews. This helped getting acquainted with the tool Architect and language ArchiMate as, apart from the training course, experience was missing. Starting with this high level end to end process seemed a good and logical starting point.

This starting point helped to slowly start understanding the complex business processes and application landscape. After about a month the end result of the customer to cash architecture became more and more similar to the already existing representation of the same process in the so called 'thin layer'. Nevertheless the efforts put into creating this architecture were not pointless. In fact these first steps proved of great value in gaining the general knowledge required to be able to understand the project specific changes to the system landscape.

Although these steps were of value the lack of knowledge slowed the overall process down. Whenever a project architect doesn't have a clear understanding of the project scope it is likely he or she will wander off. In practice this resulted into a situation in which parts of the system landscape were modeled that proved to be outside the scope of the ONDL project.

The realization that parts of the system landscape were modeled that were outside the scope of the ONDL led to an increased focus on what is inside and outside the scope of the project. A choice was made to try to divide the work in a number of subject areas. This was done with help of the project documents way of working and global functional design. These documents help project architects to get, and stay, on track. It also helped searching and selecting people to interview as the scope was narrowed down and everything became more specific. The quality of the 'as-is' architecture improved most during this last part of the approach were it became better, as in more and more in accordance with reality, with each iteration.

Issues regarding the modeling techniques and or principles encountered during creation of the 'as-is' architecture were solved by discussing the issues with an ArchiMate (modeling language) and Bizzdesign Architect (modeling tool) expert. Some views required relations between concepts which aren't present in the Tata Steel in Europe ArchiMate Meta model. These deviations from the standards will be discussed in the section that answers the research question:

- Is the subset of ArchiMate as specified in the "Tata Steel in Europe ArchiMate Meta model" sufficiently extensive to create the architectures for this project? Should an organization use an ArchiMate Meta model?

The development of the 'as-is' architecture could have gone faster if the existing 'thin-layer' architecture would have been better understood in the beginning. Understanding the 'thin-layer' provides the project architect with essential general knowledge of the business processes and the

application landscape. Which are required to understand the project specific changes. Instead all information obtained from interviews and other sources resulted in a high level overview of the customer to cash process which was very similar to that of the 'thin-layer'. Although this approach may well be the best way of learning and understanding the system landscape this certainly isn't the quickest way. Preventing the project architect from going off track would reduce the time it takes to create project architectures.

Evaluation of the approach teaches that it is easy to get off track. If the project architect is inexperienced, and has no background knowledge of the process and application landscape, efforts should be made to make sure the architect stays on track. This prevents situations in which the project architect is modeling areas of the system landscape which are irrelevant for the project and thus losing valuable and precious time.

4.3. 'as - is' project architecture

This paragraph describes and shows some of the 'as-is' architectures created for the ONDL project. The 'as-is' project architecture is created using the high level customer to cash process domain architecture, referred to as 'thin-layer', as steppingstone. Each aspect area that will be changed by ONDL is specified in figure 5. Those areas are: masterdata management, pre sales, order entry, transport planning, and transport programming.

The architecture itself can be best viewed in a web browser because it's interactive and allows the reader or user of the architecture much more easily to zoom into the required detail level he or she is interested in. The documentation which pops up when clicking on a relation or concept if available is also best viewed in a browser. The document output function of Bizzdesign Architect doesn't work very well.

A choice is made to only show and explain a small part of the 'as-is' and 'to-be' project architecture. This section describes a model which is part of the pre sales business process. The complete 'as-is' and 'to-be' project architecture can be found in the HTML output which is included with this thesis. See figure 9 for a screenshot.
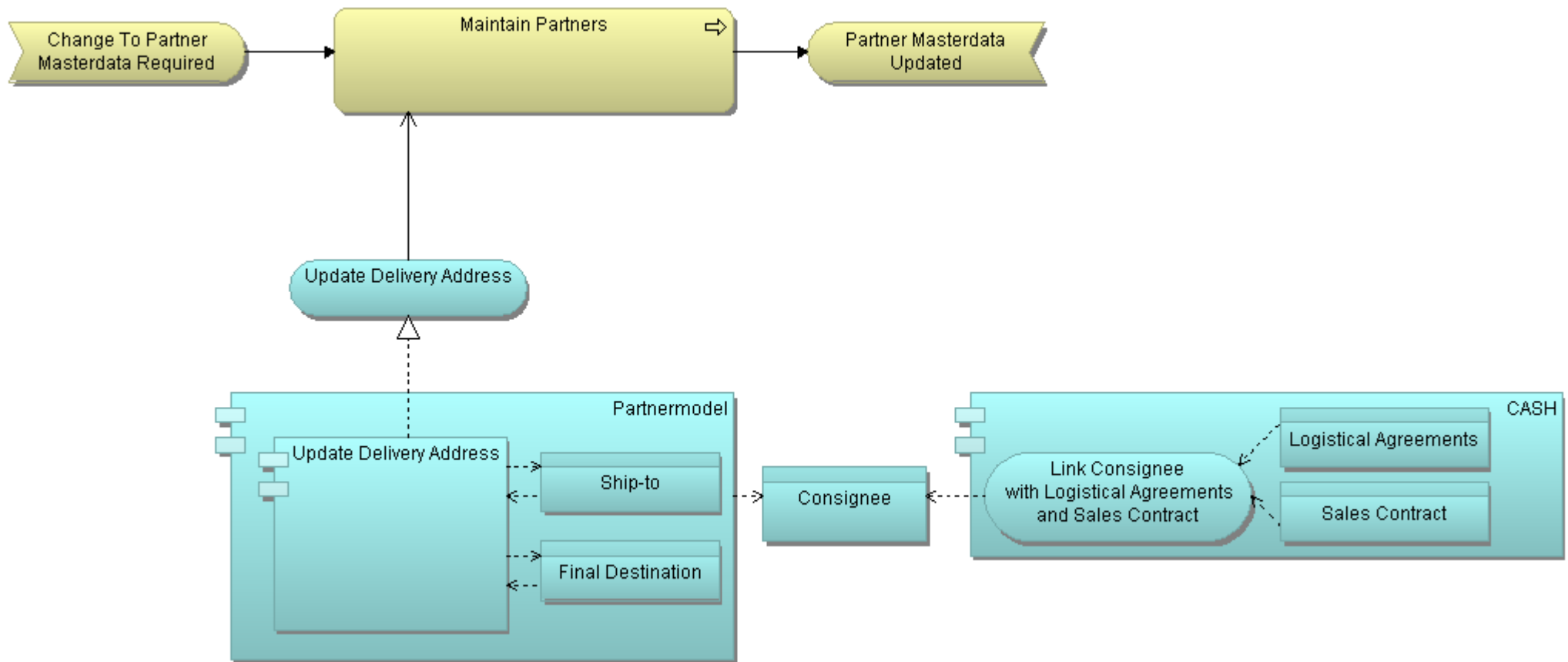
Figure 8, Maintain Partner Masterdata 'as-is'

Figure 8 shows a view on the 'as-is' project architecture for the ONDL project. The business event that triggers the Maintain Partners business process is that a change to the partner masterdata is required. Masterdata is reusable data that remains the same over a longer period of time. In this example it is about partnerdata.

The Update Delivery Address service is used by the Maintain Partners business process. The Update Delivery Address application component is a part of the application component Partnermodel and realizes the update service. Although the Maintain Partners business process consists out of more than only updating the delivery address this view only shows the updating of the deliver address as it is the only aspect that is relevant for the ONDL project.

Application component Updating Delivery Address reads and writes (updates) the Ship-to and Final Destination data objects. For each combination of Ship-to and Final Destination a data object Consignee is written by the application component Partnermodel. Data object Consignee is then supplemented with a link to the Logistical Agreements and the Sales Contract by an internal service of CASH.

The business process Maintaining Partners triggers the business event Partner masterdata Updated when finished.
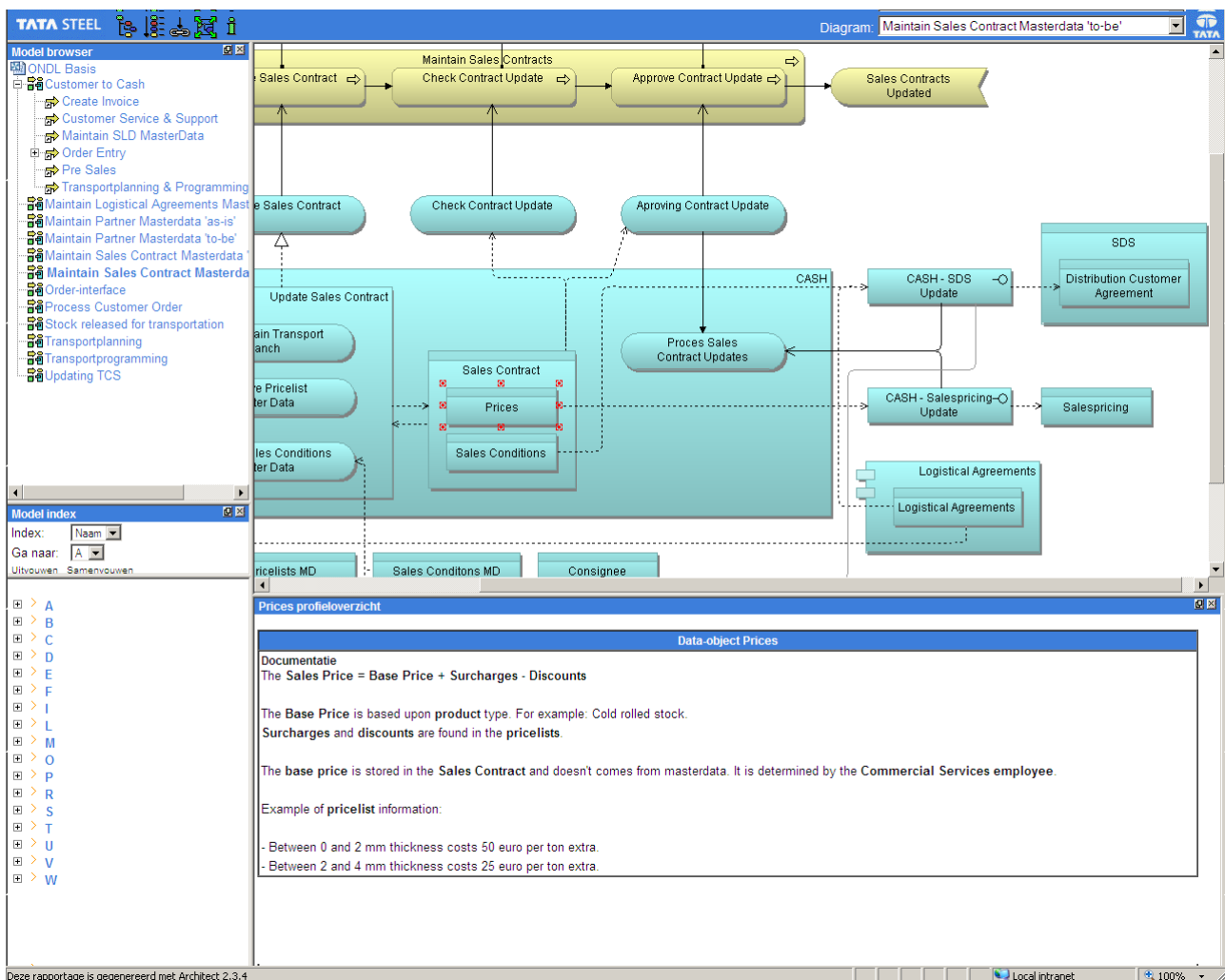
Figure 9, HTML Output including documentation

4.4. 'to-be' project architecture

This paragraph describes and shows the 'to-be' architecture created for the ONDL project. Because of time issues the 'as-is' architecture was only partially translated to the 'to-be' situation. Developing the complete 'to-be' architecture proved to be undoable in the given time. A choice was made to only model the masterdata management part of the 'to-be' situation.

Before showing and discussing this part of the 'to-be' situation it is interesting to observe that during work on the 'to-be' situation some problems emerged that indicated that the 'as-is' situation wasn't modeled in enough detail in order to clearly represent the differences between the 'as-is' and 'to-be' situation. Thus requiring some extra work on parts of the 'as-is' architecture.

As mentioned in the previous paragraph a choice was made to only show a small section of the project architecture. The 'to-be' situation shows the changes in the business process Maintain Partners and the business process Maintain Logistical Agreements which in the future situation will use an application service of the newly realized application component Logistical Agreements.

In the 'to-be' situation the data objects Ship-to and Final Destination are replaced by Site and Delivery Address which can be seen in figure 10. The data object consignee is no longer directly linked to the Logistical Agreements and the Sales Contract.
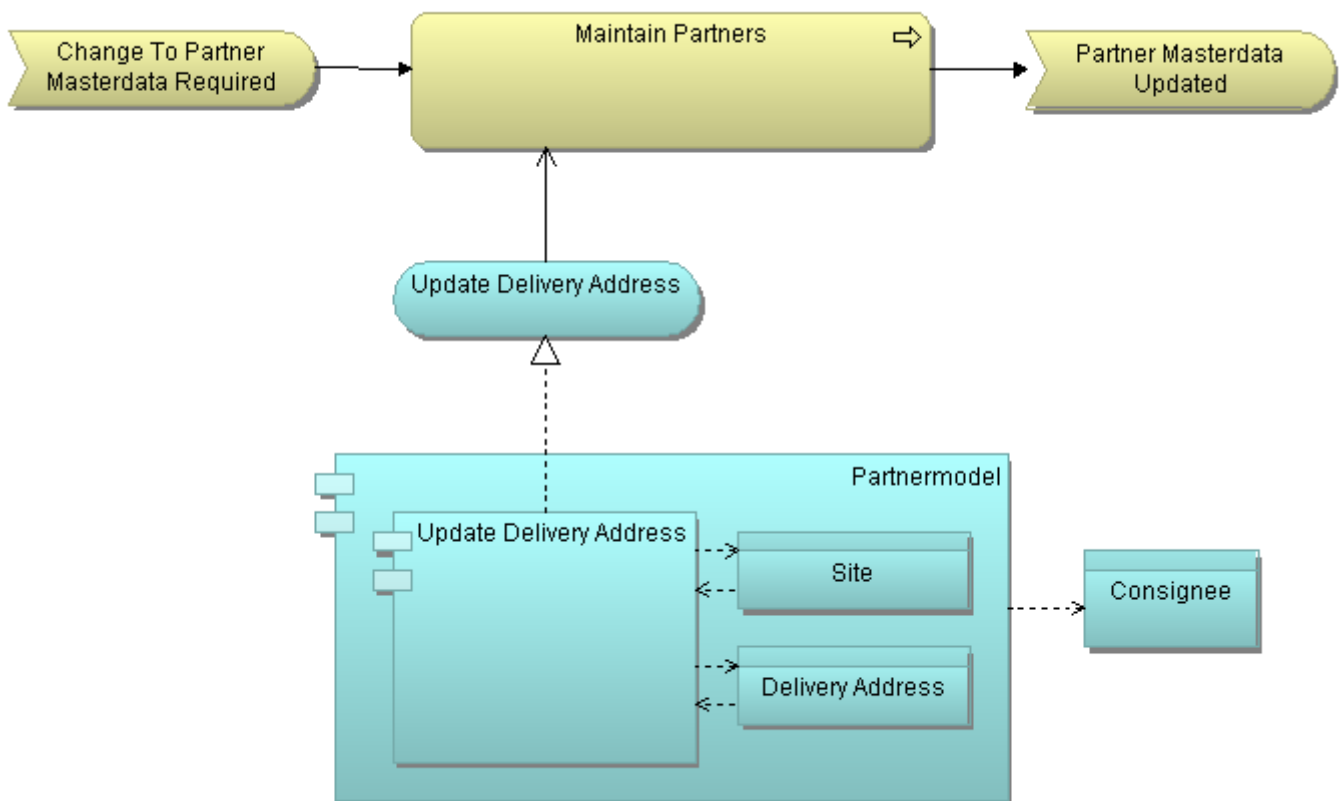
Figure 10, Maintain Partnerdata 'to-be'

The data object Logistical Agreements which is part of the application component CASH, as can be seen in figure 8, is in 'to-be' situation removed from it and put in its own application component.

Figure 11 shows the new application component and everything that comes along with it. An employee of the department Commercial Services is assigned to the business role of Logistical Agreements Editor which in its turn is assigned to the update Logistical Agreements business process.

This business process Update Logistical Agreements is used by the application service with the same name, which is realized by the application component Update Logistical Agreements. Because an application data object Logistical Agreements exists for each unique combination of data objects from Partnermodel of Site and Delivery Address it first has to be selected. The Partnerdata Selection application interface is used by the Logistical Agreements Editor and also by the internal application service Select Site and Delivery address.

After the relevant masterdata application data objects are retrieved the data object Logistical Agreements is updated. The business process Update Logistical Agreements ends with the business event Logistical Agreements Updated.
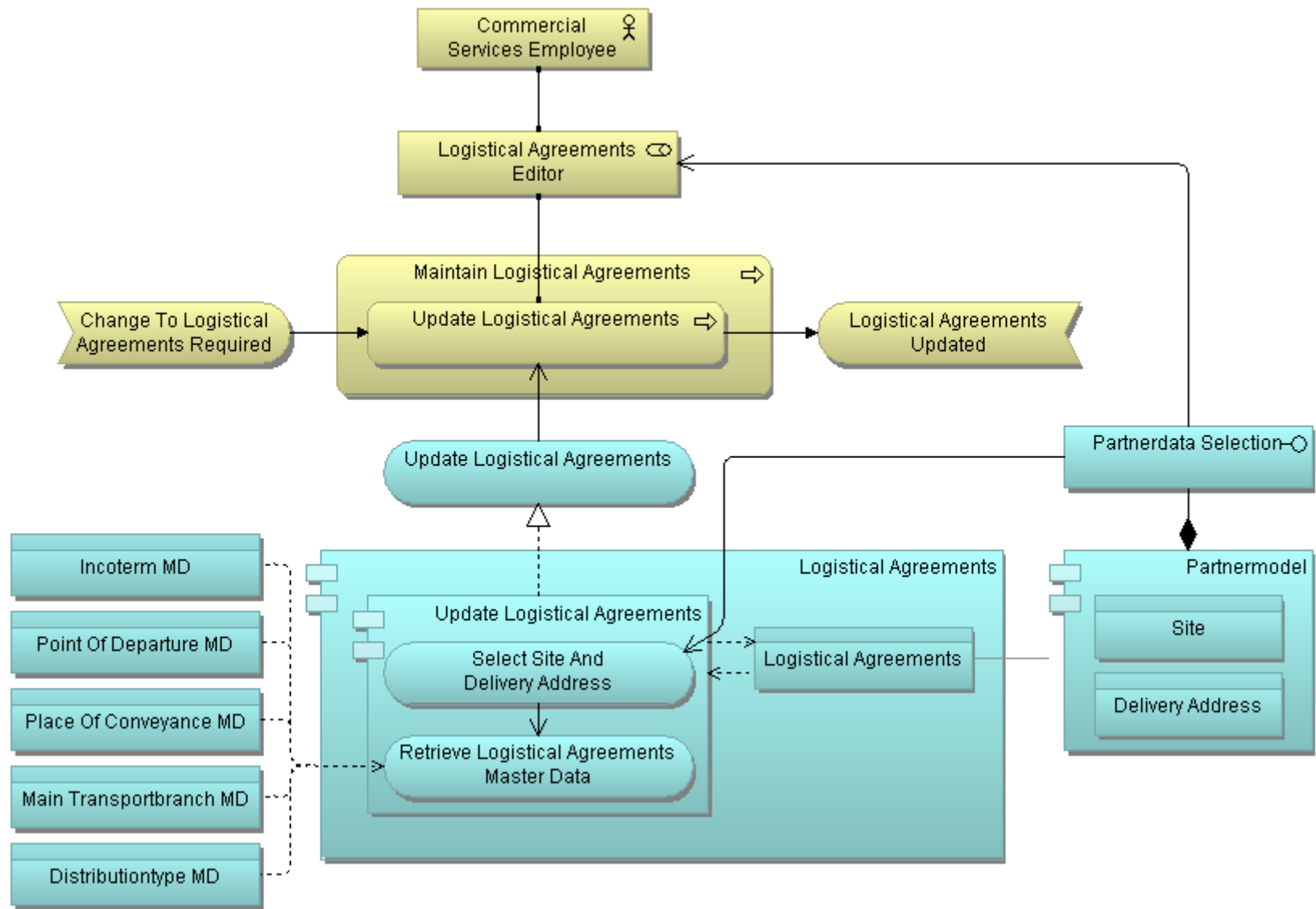
Figure 11, Maintain Logistical Agreements 'to-be'

4.5. Validation of architectures

The 'as-is' and the 'to-be' architectures need to be validated in order to check compliance to the Tata standards and the correctness of the architectures.

The architectures are validated in two ways. The first is by domain experts in the interviews. The 'as-is' and 'to-be' architectures are discussed and improved after each session until satisfactory. After that a session was organized with the Enterprise Architecture Competence center called: compliance assessment. This assessment which also results in a compliance assessment document, based upon a TOGAF document template, consists of three steps defined by Tata:

1. Initial presentation by project architect. Maximum duration: 1.5 hours.
2. Feedback session by EA Assessment team, within 1 week after initial presentation.
3. Presentation of updated architecture products.

According to this document: If the third step appears to be insufficient, a new iteration will be started. If sufficient the target architecture will be checked in in the repository.

The topics that should be addressed in step 1 are:

- Brief introduction in the topic.
- Overview of the followed approach.
- High level walk-through of deliverables.
- Explanations of deviations from the standards.
- What support was missing?
- Learning's for next phases / other projects.

The topics that should be addressed in step 2 are:

- Findings and recommendations for improvement.
- Clear overview of which steps are needed to get approval.

It was the first time a session like this was held. Both parties, me as project architect, and the people of the Enterprise Architecture Competence center had to find their way. This is one of the reasons that the initial presentation (step 1) and discussion took way more than 1.5 hours. Step 1 took two sessions and around 3 hours to complete.

These sessions were of value as we had a lot of discussions which led to numerous improvements. The outcome of the compliance assessment can be read in more detail in the Compliance Assessment document in appendix B.

The compliance assessment was only held for the 'as-is' project architecture. In theorem it should have also been held for the 'to-be' project architecture or solution architecture. However this formal step was skipped in order to save some time. The 'to-be' architecture is discussed with the domain experts and the compliance to the standards is also checked.

4.6. Conclusions

This last paragraph of chapter 4 describes the conclusions and observations that can be drawn regarding the architectures and the process of developing them. Other architects should be able to profit from the lessons learned and project architecture development approach described. But before doing so it answers one of the most important questions: is the right architecture obtained?

Passing the compliance assessment shows that the developed architecture complies with the standards and proves its correctness according to the judgment of the responsible domain architect / subject matter expert. In that sense the right architecture is obtained. Unfortunately due to several reasons the project was put on a hold. One of the consequences of this is that the architectures aren't used by the project to guide the design and implementation as discussed into more detail in paragraph 5.8. This makes it very hard if not impossible to assess the value of the architecture for the project. Nevertheless other employees of Tata like business analysts use the 'as-is' architecture to their advantage by increasing their knowledge level and understanding of the business processes and system landscape. A questionnaire held to investigate the value of working with architecture, see paragraph 5.8, also points out the value of the developed architecture.

The Enterprise Architecture modeling language ArchiMate and tool Architect are an excellent combination to develop the architectures with. For ArchiMate there are no alternatives and for Bizzdesign Architect only the less comprehensive freeware tool Archi [9] is available.

The development of the project architectures pointed out that the Architecture Development Method (ADM) [23] of TOGAF [10] isn't suited for the development of project architectures. TOGAF does not tell architects how they should create their project architectures. This observation also comes forth when discussing the architecture approach in paragraph 5.1.

At what level of detail to stop modeling is a hard question which was left to the choice of the architect. In my case this led to a situation in which work on the 'to-be' architecture had to start but the 'as-is' architecture wasn't modeled on certain areas into enough detail to adequately display the difference between the 'as-is' and 'to-be' architecture. To what detail level an organization should model is further discussed in paragraph 5.2.

Evaluation of the approach teaches that it is easy to get off track. If the project architect is inexperienced, and has no background knowledge of the process and application landscape, efforts should be made to make sure the architect stays on track. This prevents situations in which the project architect is modeling areas of the system landscape which are irrelevant for the project and thus losing valuable and precious time. Whether organizations should use 'thin layer' architectures for this purpose is further discussed in paragraph 5.5.

The compliance assessment check was of great value. It is a good way to validate and discuss the architecture and to check the compliance to the standards. Whether the TOGAF Compliance Assessment template is used for its rightful purpose is discussed in paragraph 5.1. More about how organizations like Tata can set up compliance assessment and validation steps can be found in paragraph 5.4.

The conclusions from this chapter are used in the next chapter along with additional research into the EA initiative to answer the research questions.

Part III
Results, findings, and observations

5. Enterprise Architecture at Tata Steel

Chapter 5 focuses on the Enterprise Architecture initiative. In order to investigate how to implement Enterprise Architecture in an organization the EA approach at Tata Steel is described and evaluated. Experiences, observations, and conclusions from developing project architecture and describing the approach, along with additional research into the EA initiative at Tata Steel, are used to answer the research questions.

Paragraph 5.1 is about the approach Tata Steel has developed to work with architecture. It is described and evaluated in such a way that other organizations should be able to learn and profit, or even adapt parts, from it. The next paragraph, 5.2, discusses the detail level of Enterprise Architecture and ArchiMate that should be reached. Paragraph 5.3 discusses the TSiE ArchiMate Meta Model. Paragraph 5.4 comes up with a proposal for the governance of architectural models. Paragraph 5.5 explains why the 'thin-layer' can be used as a steppingstone and why using a steppingstone architecture is of value. Paragraph 5.6 shows the compliance of the 'as-is' and 'to-be' architectures with the Tata Steel layer model. Paragraph 5.7 discusses the approach to Enterprise Architecture in an industrial organization in comparison to Enterprise Architecture in a non-industrial organization. The last paragraph 5.8 discusses the value of working under architecture by discussing advantages and disadvantages.

Due to resource and time constraints this thesis is based on one case study at one organization. This chapter tries to describe and evaluate the EA initiative at Tata Steel in such a way that other organizations should be able to profit from it.

5.1. Approach to Enterprise Architecture at Tata Steel

This paragraph describes the approach to Enterprise Architecture at Tata Steel and evaluates it. By doing so answering the research question:

- Which approach has Tata chosen to work with Enterprise Architecture? Is this approach already completely defined? What can be improved?

Describing and evaluating the EA initiative at Tata Steel allows other organizations to adopt parts of the approach and use it to their advantage. The approach Tata has chosen to work with architecture is described in a document called Enterprise Architecture @ Tata Steel in Europe (EA@TSiE). During my internship this document was expended and improved a lot. This evaluation is based on the at that time most recent version (1.0) of the document.

This paragraph is divided into a number of subparagraphs. The first subparagraph 5.1.1 describes the history and goals of EA@TSiE. 5.1.2 shows that the EA framework Tata uses is based upon TOGAF. 5.1.3 is about architecture disciplines, stakeholders, and principles which are described in the framework. The next subparagraph 5.1.4 defines the architecture deliverables. 5.1.5 discusses the link between the prince2 project approach and project architecture deliverables. 5.1.6 is about the different roles of the Enterprise Architecture function while 5.1.7. shows EA in the Value Life Cycle model. 5.1.8 discusses the compliance assessment. 5.1.9 is about the TOGAF Architecture Development Method, referred to earlier in the conclusions of the previous chapter, and the last one, 5.1.10 sums up some observations and conclusions.

5.1.1. History and goals of Enterprise Architecture at Tata Steel

Tata restarted the Enterprise Architecture initiative in November 2010. The biggest reasons to start working with EA were high impact changes to the organizations landscape. Some examples are:

- The change from Corus to Tata Steel, including the synergy challenges and opportunities which come along. Organizational changes like the new operating model

- Some very large multi-million projects not only affecting the process and system landscape of IJmuiden but that of the whole of Tata Steel in Europe.

Although the EA initiative is from 2010 Tata already made the first steps in 2008. Because of the financial crisis it was put on a low profile. The basis for the EA initiative was already laid years before, when Tata realized that neglecting all sorts of architecture would lead to local instead of global optimization.

Even earlier urges to do 'things' better made Tata Steel realize that it would be better to not only focus on the context of a specific project but to also take the big picture into account. This awareness was one of the triggers to create pictures and PowerPoint slides of aspects of the system landscape as a first start to architecture. For that purpose Tata used the SCOR (Supply Chain Operations Reference) model [15] for a while. The SCOR model is a standardized model to describe processes with. Central in the SCOR model are five processes: plan, source, make, deliver, and return.

Although Tata claims that thanks to the architecture awareness projects executed 1-3 years ago are generally more successful than those executed 5-10 years ago the SCOR model didn't realize the benefits promised by architecture. Tata hopes that Enterprise Architecture with proper tooling will realize the benefits promised when working with architecture.

The changes which triggered the restart of the EA initiative should be guided in the same direction. Tata Steel assumes that Enterprise Architecture could and should be the means to reach that direction. According to the EA@TSiE document EA should help Tata Steel in Europe in:

- Realizing the goals from an IM/IT perspective

- Support decision making

- Keep the IT landscape up to date

- Support process descriptions and process improvements as stated in the Tata Business Excellence Model (TBEM) [21]

- Objectify EA related topics

- Speed up projects

- (Re)direct programs and projects

TBEM stands for Tata Business Excellence model and is a Tata adaptation of the globally renowned Malcolm Baldrige model. A method which aims to deliver "a combination of strategic direction and concerted effort to maximize business performance." [22].

When comparing the goals to which EA should contribute to the advantages that EA should deliver, see [7] and paragraph 5.8, these goals are realistic. If EA is able to deliver the advantages it promises, realizing the goals mentioned above shouldn't be a problem.

5.1.2. TOGAF based EA framework

The EA@TSiE document describes an EA framework. The framework describes how Enterprise Architecture will be initiated and operated within Tata Steel in Europe. It is based upon the Architecture Development Method (ADM) of the Total Open Group Architecture Framework

(TOGAF) [7][10]. TOGAF is customized according to the needs and capabilities of Tata Steel. TOGAF is followed as much as possible and the customizations are being documented.

According to Tata the result of adopting TOGAF and implementing EA should be much more than "just supplying the company with some nice process-pictures". It should facilitate the changes and serve the purpose of EA which is mentioned in the previous section.

5.1.3. Architecture disciplines, stakeholders, and principles

This section describes architecture disciplines, stakeholders and principles defined in the architecture framework. Tata defines three architecture disciplines, see figure 12, development, maintenance, and governance:

1. Architecture Development

    a. Development of the Business, Information System, and Technology Architectures
    b. Development of Architecture Guidelines and standards

2. Architecture Maintenance

    a. Maintenance of the Enterprise and Domain Architectures

3. Architecture Governance

    a. Validation of Enterprise, Domain, and Solution Architectures
    b. Decision making on Architecture compliance and exceptions
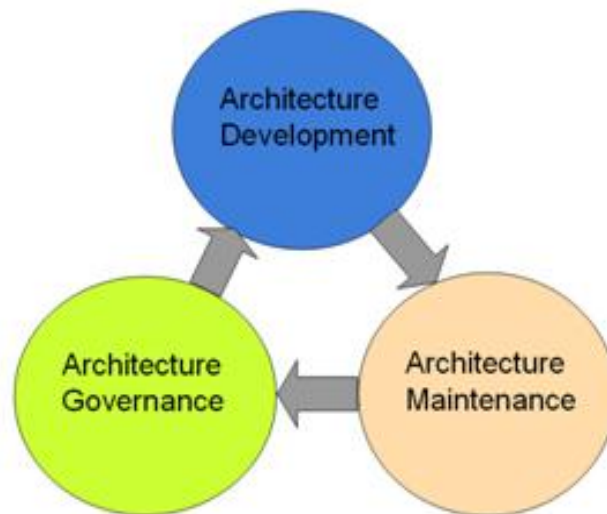
Figure 12, Architecture Discipline at Tata

Tata has defined, as should be done in the preliminary phase of a TOGAF-ADM cycle, 5 groups of stakeholders:

1. Business Management, because EA should help develop solutions to solve the businesses problems which contribute to the goals and strategy the business developed.

2. GIS Management, because EA should help creating a project portfolio which transforms the 'as-is' situation in the required 'to-be' situation and realize the goals as set by the business.

3. Project Management, because EA should help guiding a project from the 'as-is' to 'to-be' situation and at the same time make sure that the project 'to-be' architecture narrows the gap with the more long term domain and enterprise 'to-be' architecture.

4. GIS - staff, because they will have to work with, or even develop, the project 'as-is' and 'to-be' architectures. Implementation of a project should be in compliance with the 'to-be' architecture.

5. Key-users and end-users, because the key-users provide the business or project staff with valuable information on the scope of what their problems are and what to expect of a solution. And because the end-users will have to deal with the changes the project will have to their daily work.

After having defined and answered some questions, like who are the stakeholders?, which should be answered before starting up the development of Enterprise Architecture the EA@TSiE document comes up with a number of high level principles:

1. The EA function is accountable for the development, implementation, and maintenance of the Enterprise Architecture, consisting of the Business, Information Systems, and Technology architecture elements.

2. Development and implementation of EA-elements are supervised by a design Authority.

3. The Architectures are developed, implemented and maintained according to functional domains which are based on the New Operating Model.

4. Process, information systems, and technology architecture elements need to adhere to architectural guidelines and standards of the relevant domain.

5. Interactions (between processes, information systems, etc.) are based on well-defined interfaces ("services").

6. All projects and enhancements are executed under EA.

7. Approach to architecture is minimalistic and *Just-in-time*.

5.1.4. Architecture deliverables

This section describes and evaluates the architecture deliverables and coherence between them as defined in the TOGAF based architecture framework of Tata. A link between the project approach Prince2 and the architecture deliverables is established in the next subparagraph.

Tata defines a number of deliverables. There should always be a current state domain architecture, a future state domain architecture, and an ideal state enterprise architecture. To what is referred to as 'thin-layer' architectures are in fact domain and or enterprise architectures supposed to serve as steppingstone for project architectures.

Each project should deliver a Project Start Architecture (PSA) and a Solution Architecture or 'to-be' project architecture which is a worked-out description of the solution the project delivers. Figure 13 shows all deliverables and the coherence between them. The PSA is a document which "describes the boundary conditions, objectives, principles and structure of the project from the point of view of the higher level enterprise and domain architectures." An important observation is that the PSA isn't mentioned in the TOGAF document [10]. The PSA is adopted from the Dynamic Architecture EA approach of Sogeti. Sogeti [16] defines [17] the PSA as a document in which the architecture at the start of a project is described.

Whereas the architecture principles, stakeholders, and principles defined in subparagraph 5.1.3 seem well chosen and are considered to be usable for other organizations with a wish to set up their own Enterprise Architecture initiative, the deliverables, and coherence between them, allow more room for discussion.
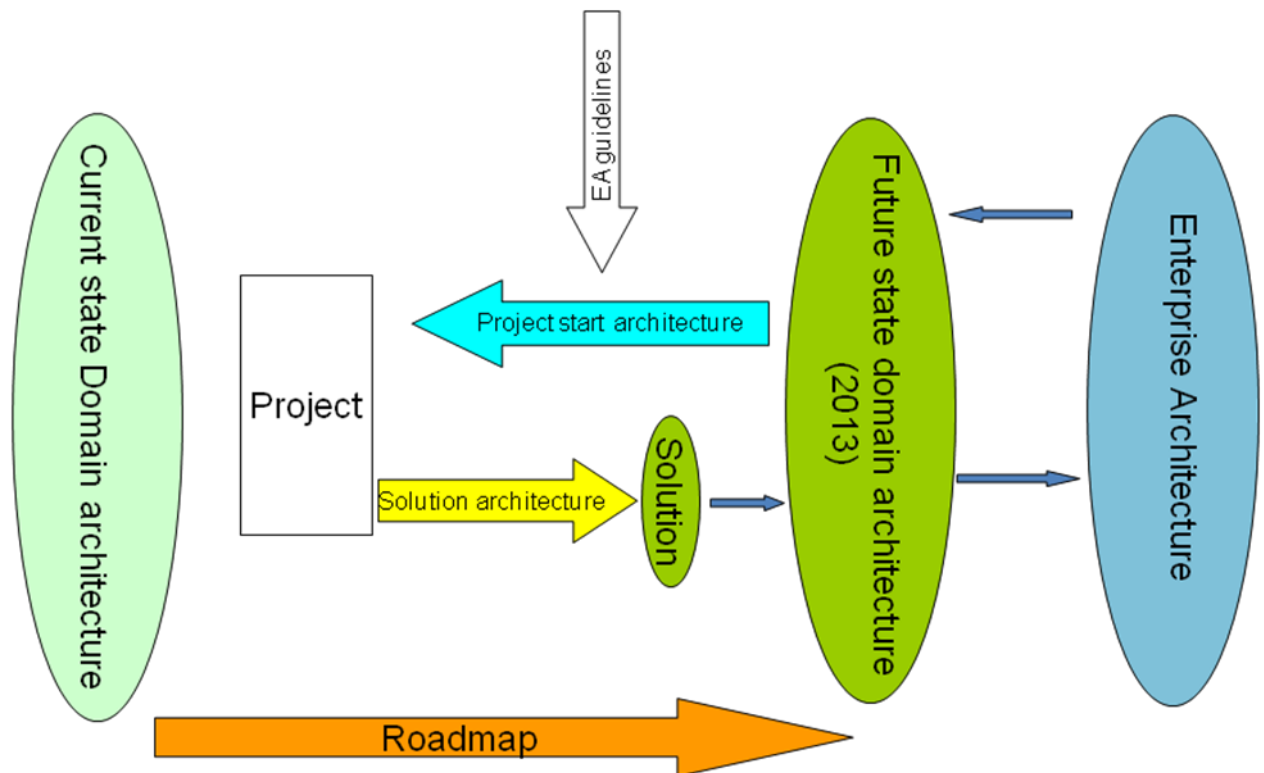
Figure 13, Coherence of architecture deliverables

It remains unclear of which deliverable the 'as-is' project architecture is part.The 'as-is' project architecture describes the system landscape and business processes at the beginning of a project. It is missing in figure 13. While in practice the creation of the 'as-is' project architecture, by developing it from scratch, or deriving and supplementing it from 'as-is' domain or enterprise architecture, proves to be a time consuming and important step which plays a major role in the overall project architecture approach. In order to know the path to the solution and to show the difference between the current and future situation, an 'as-is' project architecture is required. The conclusions and observations that can be drawn regarding the architectures and the process of developing them as described in paragraph 4.6 underline the need for an 'as-is' project architecture.

The 'to-be' project architecture should be part of the solution architecture. The 'as-is' project architecture isn't discussed in the EA@TSiE document but should be a deliverable on its own. The choice to put the project architectures into separate deliverables can be defended easily because both deliverables are delivered on different points in time, and thus pulling them apart is a good idea.

5.1.5. Architecture deliverables and prince2 project management

This subparagraph establishes a link between the prince2 project management approach and the EA deliverables, including the 'as-is' project architecture, as discussed in the previous subparagraph.

[18] is one of the few literature sources which discusses a combination of the prince2 project approach and Enterprise Architecture. It states that the PSA should be finished in the beginning of the initiation phase. Tata made the same choice in their TOGAF based architecture framework.
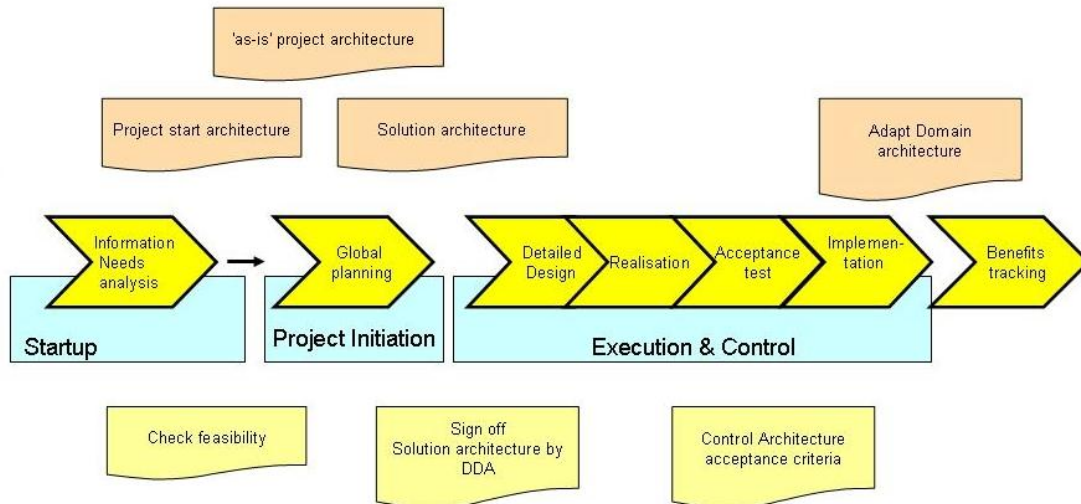
Figure 14, EA and Project Management

Figure 14 shows the role of EA in project management. This figure is used to show when which deliverables should be ready according to Tata. The project approach of Tata is discussed in chapter 2 paragraph 5.

The PSA should be finished somewhere between approval of the project brief and work on the global functional design. That is, as can be seen in figure 14, somewhere in the beginning of the initiation phase. The 'as-is' project architecture should be finished after work on the global functional design is completed and the initiation phase ends. The solution architecture should be finished after the global functional design is finished and work on the functional design / detailed design is well on its way, at the beginning of the realisation phase.

The choice of Tata to finish the solution architecture just before the detailed design is ready seems logical. When developing the solution architecture and at the same time the global functional design discussions about the actual solution will arise. In other words, you won't know how the final picture will exactly look before you have designed it into detail.

To conclude this part of the approach some efforts should be made to clarify the role and position of the 'as-is' project architecture. The EA@TSiE document does state that there are 'as-is' and 'to-be' project architectures but doesn't explain of which deliverable they are part. The 'to-be' project architecture is the easiest, it should be part of the solution architecture. The 'as-is' architecture should be a deliverable on its own, next to the project start architecture.

5.1.6. Roles of the EA function

This subparagraph is about demands on the EA function in generic terms. According to Tata "The role of EA-function to the business is to facilitate (visualize) the decisions: which concerns and goals will be met / lost in which case." Furthermore the architect should formalize decisions and control decisions.
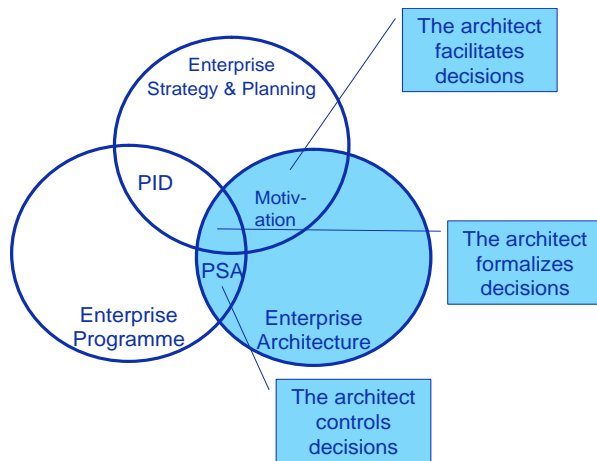
Figure 15, EA role in perspective

Figure 15 shows the three roles of the EA-function. EA should show all relevant EA aspects to allow the business to make the right decisions. The architect controls decisions by "safeguarding the 'contract' between the project/programme regarding the EA in the form of the Project Start Architecture".

This also is somewhat confusing because now only the PSA is mentioned. It certainly is a good idea to control the decisions made by the business and thus to safeguard the contract between EA and project/programme. However this is done in two ways. The first is by validating whether the project implementation is in alignment with how the final picture should look like, as is decided by the business. According to Tata validation is done on basis of the PSA while it seems much more logical to check compliance of the implementation with the solution architecture. Using the solution architecture would also be more in line with the governance paragraph in the EA@TSiE document which states that each solution architecture is checked and approved by Domain Design Agencies, who have the task to validate solution architectures. The second is by setting requirements for the projects which come from the 'to-be' enterprise and domain architecture as is done in the PSA.

The PSA in figure 15 should be replaced with project architecture (PA) as both the PSA and the solution architecture (SA) should be used to safeguard the contract between the project/programme and EA.

5.1.7. Enterprise Architecture in the Value Life Cycle Model
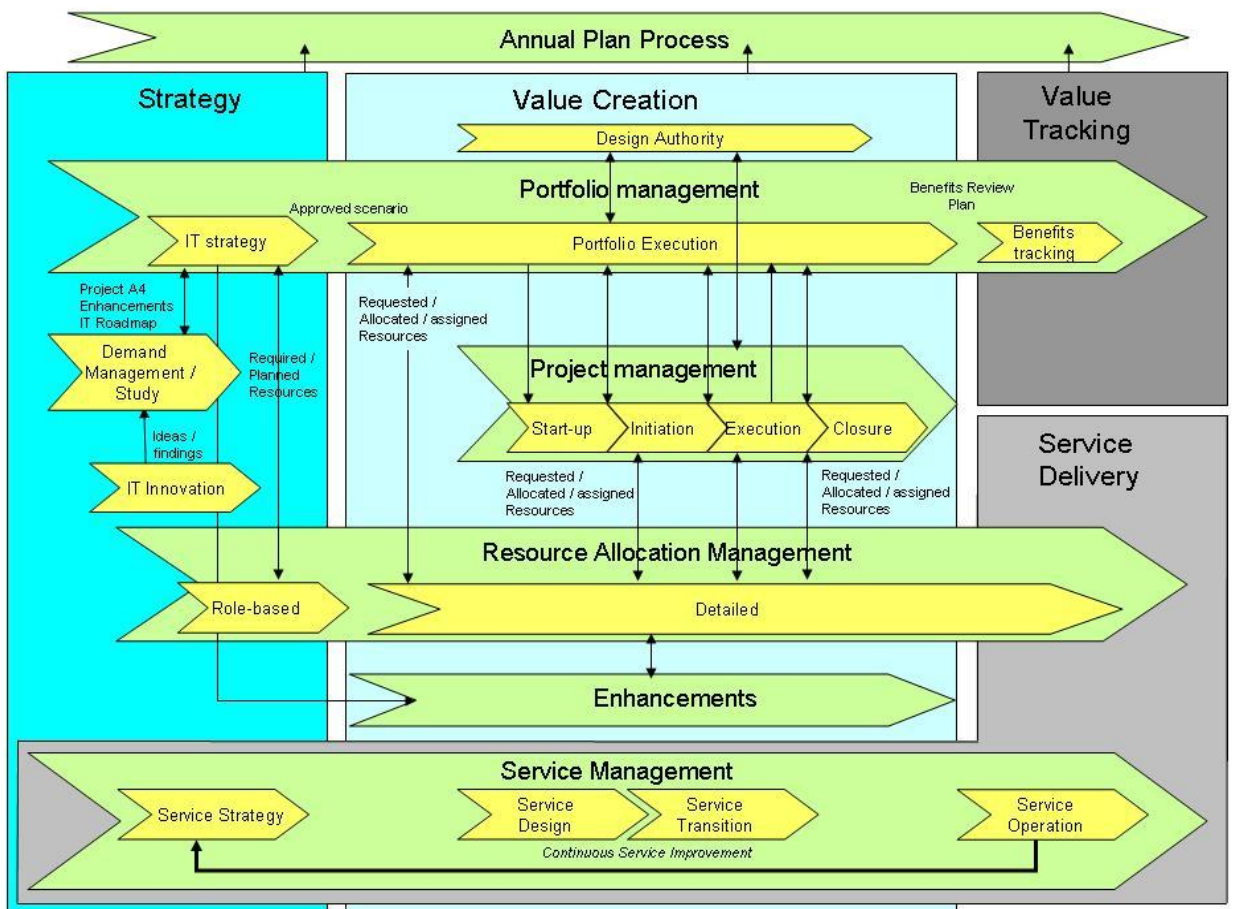
Figure 16, Value Life Cycle Model

This section describes the position of EA in the Value Life Cycle Model. Figure 16 shows the model with all the processes which are part of the Group Information Services (GIS) organization. Although according to Tata all processes have EA-aspects in them a choice is made to focus only on the value creation phase and more specifically on the project management process because this subject area is most relevant in this thesis. Experience obtained from working with EA is mostly obtained by creating the 'as-is' and 'to-be' project architectures.

5.1.8. Compliance Assessment

Before moving on to the conclusion of this paragraph two more things need to be discussed. This section discusses the Compliance Assessment which was also organised for the 'as-is' project architecture as described in paragraph 4.5.

The EA@TSiE document describes that the domain design agencies are responsible for the validation of solution architectures. However the purpose of the Compliance Assessment is defined as: "To ensure that the original Architecture Vision is appropriately realized and that any implementation learning's are fed back into the architecture process.". While in this thesis the Compliance Assessment was used to validate the 'as-is' project architecture.

Three different things which should also be treated as such. It would be better to make a distinction in the EA@TSiE document in validating the 'as-is' and 'to-be' project architectures on one hand and compliance assessment of the actual implementation to the solution architecture, or 'to-be' project architecture on the other hand.

The Compliance Assessment document template which Tata adopted form TOGAF is now used for validation of the 'as-is' and 'to-be' project architectures. Using the validation approach as shown in paragraph 4.5 worked very well and doesn't have to be changed. The template document of TOGAF describes a wrong purpose so it would be better to just forget the TOGAF template and introduce a customized validation document for the 'as-is' project architecture and for the solution architecture. The compliance assessment document can and should be used when checking the compliance of the actual implementation with the way the end situation should look as defined in the solution architecture.

5.1.9. TOGAF Architecture Development Method

The last aspect which needs to be discussed before moving on to the conclusions is the TOGAF Architecture Development Method (ADM) [7][10]. It is important to realize that the ADM is only suited for higher level architectures. To concretize that: The ADM can and should be used for the current and future state domain and enterprise architectures but explicitly not for the project architectures.

Although the EA@TSiE document states that it describes the way TOGAF will be used in Architecture-related projects it in fact does not. Although one could argue that the architecture development phases Business Architecture (B), Information Systems Architecture (C), and Technology Architecture (D) are executed in projects some other are certainly not.

Phases E and F, Opportunities and Solutions, and Migration Planning, for example are not created to be executed while working on project architectures. One of the goals of the Opportunities and Solutions phase is to come up with delivery vehicles that deliver the target architecture. The Migration Planning phase transitions those delivery vehicles into detailed plans and comes up with transition architectures. Obviously delivery vehicles and transition architectures are not applicable on, and relevant for, project architectures.

5.1.10. Evaluation and conclusion

Altogether the architecture approach at Tata as described in the EA@TSiE document is comprehensive and well defined. Although some aspects could be improved generally speaking the approach already is quite mature. The observation that the ADM of TOGAF is not suited for project architectures doesn't have to be a problem at all. The approach should clarify to which deliverables the 'as-is' and 'to-be' project architectures belong. The validation and compliance steps should be pulled apart into validation of the 'as-is' and 'to-be' project architectures and compliance check of the actual implementation to the solution architecture.

To answer the last part of the research question addressed in this paragraph:

- Is this approach already completely defined? What can be improved?

The answer to the first question would be yes. Is the chosen approach correct? It is already quite mature and can be further improved. If the steps mentioned above are taken the answer is definitively yes.

5.2. Detail level of Enterprise Architecture and ArchiMate

This paragraph describes up to what level of detail Tata has chosen to model using ArchiMate and at which point they switch to other tools, languages and or techniques. The experience obtained from developing project architecture is used to evaluate this choice and define to what level of detail an organization should model their project architecture using ArchiMate. By doing so answering the research question:

- Up to which level of detail has Tata chosen to model using ArchiMate and at which point do they switch to other, for example not Enterprise Architecture related, techniques? Up to what level should an organization model?

The approach to Enterprise Architecture, as discussed in paragraph 5.1, has shown that Tata uses modeling language ArchiMate from the highest level business processes, the end to end processes, see paragraph 2.4, to within projects. That ArchiMate starts at the Enterprise Architecture level is clear and a well-defined starting point. When to stop using ArchiMate and switch to other languages and or tooling is a more difficult question.

When looking at an organization as a city the future or 'to-be' Enterprise Architecture can be best compared with a zoning plan. The Domain Architectures can be best compared with more detailed zoning plans for specific districts. Project architecture should be seen as an actual plan for change in a certain district, or with very big projects even over one or more districts. There is no discussion on using ArchiMate as the modeling language for the zoning plan of the whole city and that of specific districts. There is also no discussion on the usage of ArchiMate within projects. The most important question that still remains unclear is to model to what detail level in projects. Should an organization use ArchiMate to model the specific working of a lock of a front door of a house? Or should we stop modeling at the front door? Or even the whole house?

In practice it proves to be very hard to come up with a clear answer to this question. It is nearly impossible to define a uniform stopping or switching point. Therefore the responsibility should be given to the project architect. He or she should decide what level of detail is required for each project in order to realize the benefits which come from executing projects while working under architecture.

The experience obtained from developing the ONDL 'as-is' and 'to-be' project architectures taught that selecting the right level of detail can be more difficult than one might expect on forehand. A situation emerged in which the work on the 'as-is' architecture was finished and I wanted to start with work on the 'to-be' architecture but couldn't do so because the 'as-is' architecture didn't have the necessary detail level to show a clear distinction between the 'as-is' and 'to-be' project architecture. And that in spite of the fact that ONDL is one of the bigger projects.

Another observation which came forward during modeling was a required way of modeling which required switching to other languages like BPMN [19]. When for whatever reason the architect wishes to model procedural business or applications aspects in which conditional statements play an important role ArchiMate isn't the right language to do so. BPMN would be a good alternative. In the documentation of the project architecture a link to the BPMN model can and should be made.

To conclude this paragraph, no concrete stopping point can be defined. The starting point, the highest level business processes, and the lower limit, the need to model conditional statements, are clear. Everything in between is for the responsibility of the project architect which should find the right level of detail. Required to visualize the differences between the 'as-is' and 'to-be' architecture in order to realize the goals of EA.

## 5.3. The TSiE ArchiMate Meta Model

This paragraph describes the experience with using the Tata Steel Meta Model, see figure 6 and paragraph 4.2. By doing so answering the research question:

- Is the subset of ArchiMate as specified in the "Tata Steel in Europe ArchiMate Meta model" sufficiently extensive to create the architectures for this project? Should an organization use an ArchiMate Meta model?

To directly answer this research question: Organizations should most definitively use an ArchiMate Meta Model. It limits the complete ArchiMate language and helps an organization stimulating uniform modeling conventions. The ArchiMate Meta model is sufficiently extensive and thus very well suited to create the architectures for the ONDL project. Nonetheless certain parts of views are in violation with the meta model and deviate from the standards. These deviations from the standards are also documented in the compliance assessment document in appendix B.

In some occasions an information flow is used. Figure 17 shows three information flow relations between application components. Although allowed by the meta model the modeling standards strongly prefer relationships between application components through an application interface or service.

Because the purpose of this view is to show that certain data flows to the ISMPL application component and the how question is less relevant the choice to use information flows is accepted.
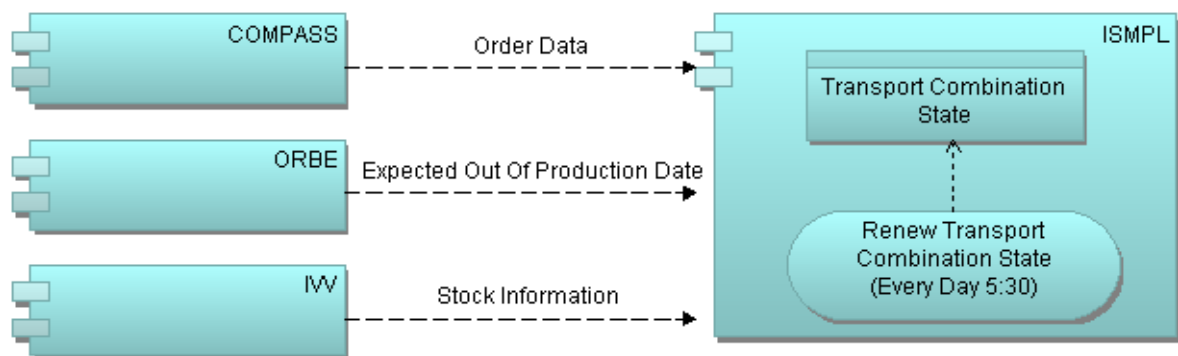
Figure 17, Information - flow relation

Another deviation from the standards which is in violation with the meta model is an access relation between application services or interfaces and data objects. Figure 17 shows an internal service with an access (write) relation to a data object.

This relationship is always allowed for internal services which are part of an application component. However when an external application service or interface directly writes or reads a data object the application service should at least be realized by an application component and the application interface should have a composition relation with an application component.

5.4. Governance of architectural models

This paragraph comes up with a solution for the governance of architectural models. It discusses how architectural models should be maintained, what validation mechanism should be in place, and describes some principles which support the proposed governance structure. By doing so answering the research question:

- How should governance of architectural models be organized?

Architectural models should be managed. The best option would be using a repository to store them. A repository can help preventing duplication of models and or objects, allows users to view the most recent version of a model, and supports the re-use of architectural concepts.

Once the repository is in place new projects should check out that part of the domain architecture from the repository to which the project will apply changes. The checked out architecture should

form the basis for the 'as-is' project architecture. The following EA principles support the governance structure by ensuring that domain architecture is available or will be created:

- "If a domain architecture for the area of the project exists, this should be used as starting point to create the project architectures."
- "If not, a request has to be issued to the EA-function to create one."

Already available architectures should all be connected to the high level enterprise or domain architecture, referred to as 'thin-layer' (paragraph 5.5), and then added to the repository. The checked out architecture should form the basis for the 'as-is' project architecture. The 'as-is' project architecture should be expanded until it reaches the right level of detail and is complete enough.

Sogeti claims, in a white paper [18] that the project architectures should be kept on their own and that changes should be propagated to the complete architecture, which they refer to as reference architecture and Tata refers to as 'as-is' enterprise or domain architecture.

It would be better to work with a repository and checking out relevant parts of the system landscape and checking them back in after changes, as proposed in this governance structure. Working with a repository helps an organization having a central architecture and don't having to worry about numerous project architectures which are all scattered throughout the organization.

Unfortunately version 2.4.3 of Bizzdesign Architect, still in use at Tata Steel doesn't properly support a repository. However version 3 of the Enterprise Architecture tool does have repository support [24]. The repository works on the basis of Oracle [13] or SQL Server [14], supports version control and multiple users all with their own authorization level.

Besides the storage structure and principles another aspect of the governance is the validation and compliance assessment of the (project) architectures. Project architecture deliverables, the solution architecture and the 'as-is' project architecture, will have to be checked and approved by so called Domain Design Agencies. The task of Domain Design Agencies is to validate architectures.

Checking in and out prevents other projects from modifying the architectures and thus conflicting with each other. Before checking in architectures to the repository two requirements need to be met. The first is that architectures will have to be presented by the project architect to the Enterprise Architecture Competence Center of Tata. The Competence Center verifies by looking at the architectures whether the project architect has created the architectures in compliance to the standards and guidelines, like for example the Tata Steel meta model. The second is that the architecture has to be validated by the Domain Design Agencies. Only if both parties give the green light the architecture is allowed to be checked in again.

For the ONDL project this would mean checking out those concepts of the customer to cash process that the project will affect. Paragraph 3.4 highlights these concepts as can be seen in figure 5. Changes to the system landscape which require updates to the architectures should be realized through projects, executed under architecture.

5.5. 'Thin-layer' as steppingstone

This paragraph describes whether the existing 'thin-layer', see figure 18, a high level overview of the most important end to end processes, can be used as a steppingstone for project architectures. By doing so answering the research question:

- Is the existing high level business description, referred to as 'thin-layer' suitable as a steppingstone for the architectures created within the ONDL project? Should an organization have an architecture that can be used as steppingstone?

The 'thin-layer' consists of a high level description of the end to end business processes as shown in 2.4. Figure 18 shows the high level representation of the end to end process customer to cash which is the most important process for ONDL. The same representation is used for highlighting subject area's to which ONDL will apply changes as can be seen in 3.4.

As discussed in 4.2.5. the approach taken led to a similar representation of customer to cash as found in the 'thin-layer'. After realizing this a switch was made to the 'thin-layer' version as it was more mature and precise. More detailed architectures are coupled to the ONDL subject areas (3.4) using the 'thin-layer' as a steppingstone.

In practice this proved to work very well. Using the 'thin-layer' as a steppingstone feels natural. Prior to switching to the 'thin-layer' my own representation of the customer to cash process was used as a steppingstone for the more detailed architectures. So in fact the 'thin-layer' could have been used earlier as steppingstone without even knowing it.

This further convinces me in claiming that the 'thin-layer' should be perfectly suitable as a steppingstone as it should be possible to connect each project architecture to one or more elements of the high level business architecture. In general it seems to be a good idea for an organization to always have a steppingstone in the form of a domain or enterprise level business architecture for project architectures to connect to. This has at least two advantages.

The first is insight by showing to which high level business process or processes the project will apply changes to. The second is connecting all project architectures to each other. Let's for example assume a house to be the equivalent of a system landscape of an organization. If a project is to change the locks on the front door it would be a good idea to connect the project architecture to a high level description of the house which defines for example the front door. This provides insight to everyone involved and makes sure that the locks of the front door are changed and not those of the garage nearby. And if combined with using a repository as governance solution to architectural models, as discussed in the previous paragraph, checking out the front door for work on the locks prevents other or similar projects from intervening like for example painting the door in another color (assuming that both projects can't be executed parallel).
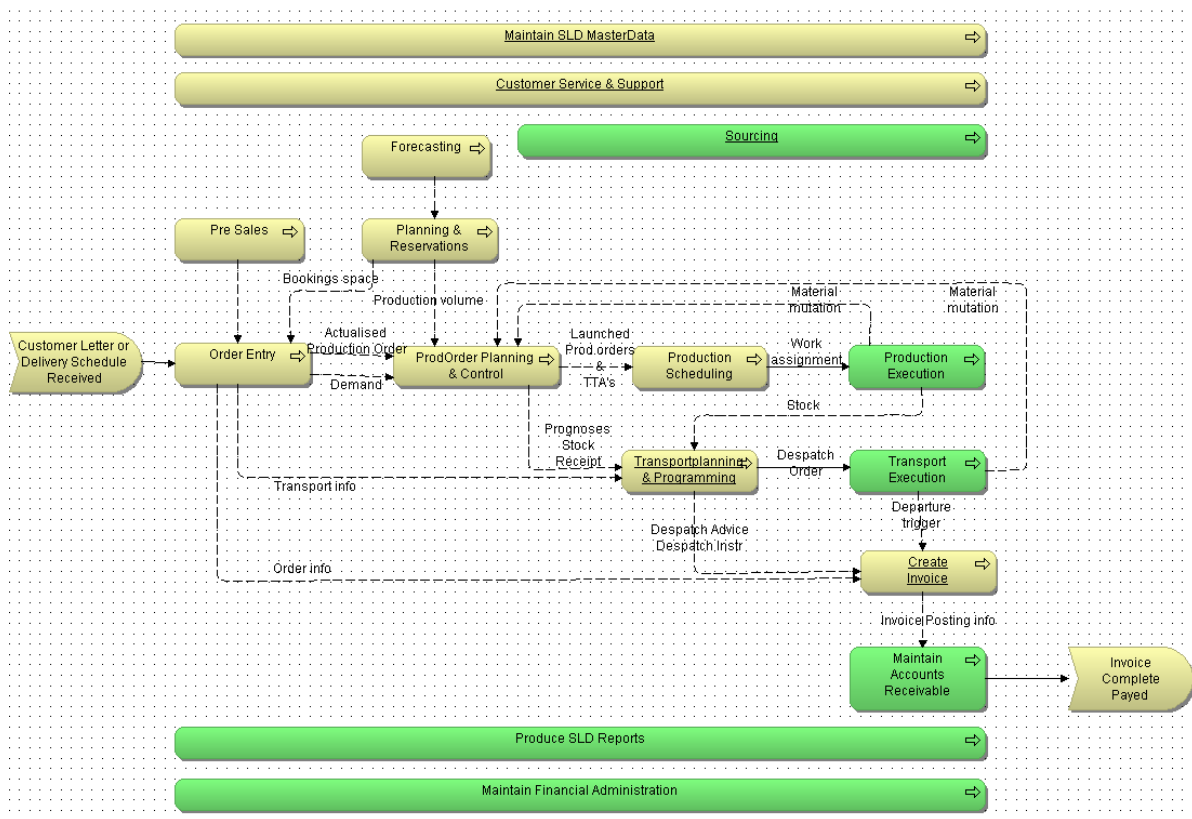
Figure 18, Representation of Customer to Cash in 'thin-layer'

5.6. Compliance of architecture to Tata Steel Layer model

This paragraph discusses the compliance of the architectures to the Tata Steel Layer model. By doing so answering the research question:

- Is the end architecture of the ONDL project compliant to the layer model as is standard within Tata?

The Tata Steel layer model divides the system into 5 levels. This model is part of the Tata Steel functional reference model. The functional reference model clusters business processes according to IT characteristics. The model consists out of 5 levels or layers with each layer having its own closed control loop. The higher level steers a lower level and a lower level provides the higher level with status and result information.

Figure 19 shows the functional reference model and its 5 levels. The financial systems and services and supporting systems are placed in separate triangles. The financial systems are placed in the middle because transactions come from both plant systems and services and supporting systems.
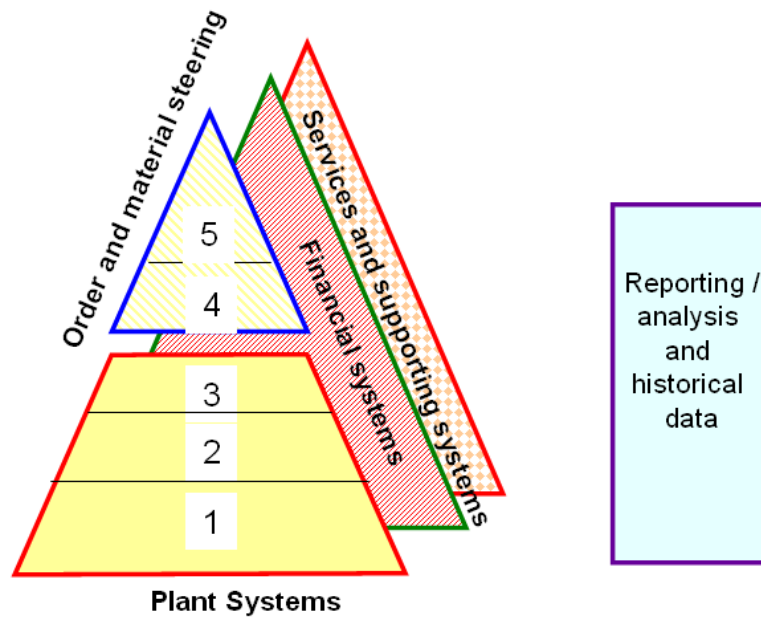
Figure 19, Tata Steel functional reference model

The goal of the functional reference model is to create logical groups of cooperating or similar functions modelled and represented including relations between these groups in order to serve as a basis for:

- Requirements and or guidelines for system grouping or separation.

- Requirements (standards) for design structure and accompanying tools

- General division of control and or structure of the organization, management, and communication

The 5 levels all have their own characteristics, cycle time, and technology as can be seen in figure 20. From the highest to the lowest these levels are: Order management / supply chain planning, supply chain steering and logistics, plant control / production planning, process control, and installation control.

NR	Application	Characteristic	Cycle Time	Technology
5	Order management Supply chain planning	Site	< 8 hours	DB2 / IMS Java / Cobol / Browser /OMP
4	Supply chain steering Logistics	Site	< 10 min	DB2/ IMS Java / Cobol / Browser / OMP
3	Plant control / Production planning	Factory	< 5 sec	Oracle Microsoft .Net / C# /OMP
2	Process control	Group of Installations	< 1 sec	Several, supplier dependent
1	Installation control	Installation	<100 msec	Several, Supplier dependent

Figure 20, Levels of the Tata Steel reference model

Any project that applies changes to the system landscape should make sure that it is compliant to the reference model. Being compliant to the reference model basically means making sure that no levels are skipped. An element of one layer isn't allowed to directly communicate with an element of more than one layer higher or lower. To put it simply this for example disallows high level order management processes to communicate directly with plant control systems or even installations within a plant.

In order to check this for the ONDL architectures all application components and corresponding business processes are checked on communication with other application components or business processes. The outcome is that all application components affected by ONDL only communicate with elements from the same level or maximum one level higher or lower. In fact all application components and business processes are from either level 5 or level 4.

As no level 3 and lower level systems are included in the project the research question can be answered relatively easily: the end architecture is compliant to the Tata Steel reference model as no violations to the layer model can occur.
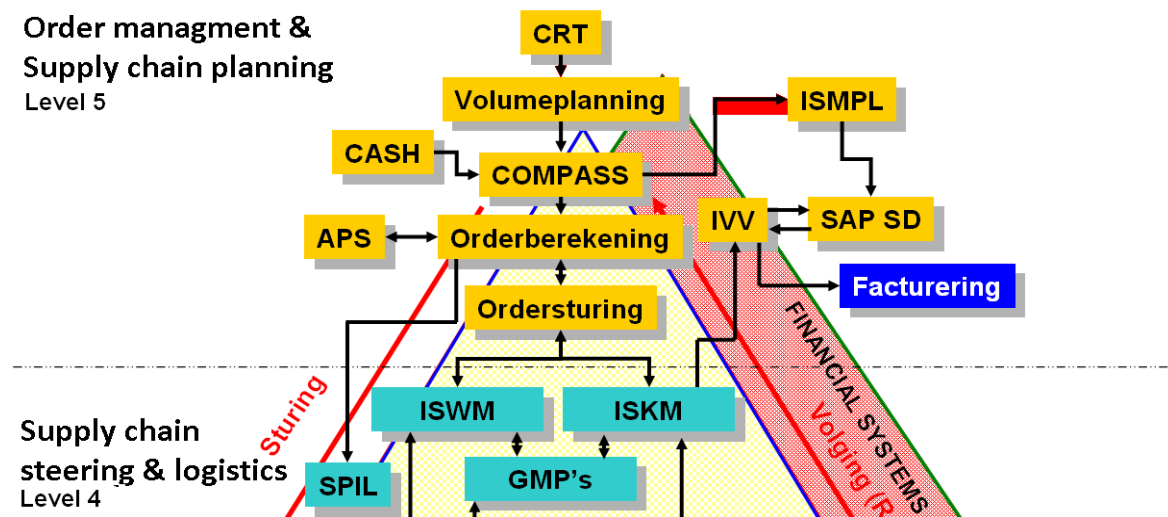
Figure 21, Plot of most important systems and processes on level 4 and 5

Figure 21 plots some of the most important application components and business processes on the Tata Steel reference model. The figure only shows level 4 and 5. The lowest level systems modelled in the 'as-is' and 'to-be' architectures are ISWM (Information system hot milled stock) and ISKM (Information system cold milled stock).

5.7. Enterprise Architecture within an industrial organization

This paragraph describes an aspect of the approach to Enterprise Architecture which is considered to be specific for industrial organizations. By doing so answering the research question:

- Tata Steel is an organization with its core business in producing steel. What observations can be done regarding working with Enterprise Architecture in such an industrial organization? Are there specific ways in which the architecture approach needs to be customized?

Enterprise Architecture in general is most mature in information processing intensives like insurance companies or governmental organizations like municipalities. Although the core

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business of Tata Steel is producing steel the system landscape and business processes are at least just as complex as those type of companies just mentioned.

No major customizations to the architecture approach are needed. The only major difference is that the business processes and system landscape are different. Factories / production sites are in an industrial organization part of the system landscape.

Industrial organizations tend to make use of reference models. Reference models, like the one Tata uses, see paragraph 5.6, classify each process in a certain level where the higher level steers a lower level and a lower level provides the higher level with status and result information while disallowing direct communication between more than one layer or level.

This puts extra constraints on the architecture's created or developed as they need to be in compliance with those reference models. This difference in comparison to information processing intensives should be taken into account and come forth out of the architecture approach.

Tata validates the compliance to the Tata Steel Reference Model in the validation sessions of both the 'as-is' and 'to-be' project architecture. Furthermore the EA handbook TSiE, a document which describes the Enterprise Architecture Modelling Standards at TSiE, shows how in the documentation a link can be established to the corresponding level or layer of the reference model.

To conclude this paragraph and answer the research question: The main difference is that an industrial organization has different business processes because there core business is in producing something. As industrial organizations tend to make use of reference models the compliance to these models need to be built in and included in the architecture approach.

5.8. Advantages and disadvantages of working with architecture

This paragraph describes the advantages and disadvantages of working with architecture. By doing so answering the research question:

- What are the advantages and disadvantages of developing and using business and application architectures within the ONDL project?

First the most important disadvantages are described as the disadvantages are a lot clearer and easier to understand than the advantages. Besides that the disadvantages are quite trivial. The disadvantages can be described in time, resources, and money.

Working with architecture requires setting up architecture. Setting up an approach costs time of employee's and thus resources and money. Employees working with or developing architecture must be trained. Working with architecture means more overhead, more project deliverables, and could potentially slow the project down.

The most important question that the field of Enterprise Architecture faces is proving that the advantages outweigh the disadvantages. An anything but trivial question as quantifying the benefits and advantages is very difficult.

Unfortunately due to several reasons, among which political ones, the ONDL project is put on a hold. For now, only a small part of it will be implemented. One of the consequences, at least for now, of this is that the created architectures won't be used. This makes investigating the added value for the ONDL project hard if not impossible.

Off course then the question arises: Could a more mature project architecture, at the time of putting ONDL on a hold the 'as-is' architecture was nearing completion and work on the 'to-be' architecture still needed to be started, have prevented this? Answering this question is difficult. A

definitive answer can't be given. What can be argued is that having a worked out project architecture would have made the decision to put ONDL on a hold harder.

The 'as-is' and 'to-be' project architecture could have been used to concretize and show the value of business improvements the project claims to deliver. The project architecture serves as a communication means to convince decision makers to continue the project.

One of problems encountered in the project was that multiple stakeholders had different, sometimes conflicting, expectations of the goals the project should realize. That different stakeholders have different interests in the project is almost always the case and doesn't have to be a problem. The challenge is to make sure that when a project starts the project goals are clearly defined and to communicate this to each stakeholder in such a way that each one of them knows what to expect and which goals will be realized and which won't be realized. During the project decision makers found out that this was not the case.

The motivation extension of ArchiMate [20] can help by visualizing the goals of each stakeholder. Conflicting goals can be detected and discussed in an early stage which could have prevented some of the problems that occurred in the ONDL project. The motivation extension can also be used to show to what goal or goals each change to the system landscape and or business process contributes. If and how the motivation extension should be used is outside the scope of this thesis and is considered to be future work.

Whether or not having an 'as-is' and 'to-be' architecture with or without the motivation extension would have prevented the project being put on a hold remains unknown. Nevertheless architecture could have helped prevent some problems and the architecture itself could have been used as a communication means to decision makers to convince them of the value of ONDL for the business.

Advantages of working with architecture as mentioned in my literature survey [7] are: Alignment to the mission, reducing project costs and time, reduced technical risk, and improved interoperability and integrations. Unfortunately these advantages are either almost impossible quantifiable or are more long term advantages.

Even if the ONDL project wouldn't have been put on a hold it would have been difficult to prove that EA realized these advantages. In order to prove them in a scientifically justified and solid way the project would have to be executed in parallel with and without architecture. This however isn't realistic.

The next best thing given the situation was to try to prove the value of the created architectures. This was done by first presenting the architectures, the HTML output, to potential users of the project architectures. After the presentation a questionnaire was handed out which questions the value of Enterprise Architecture and the developed project architecture for ONDL.

The questionnaire requires the questioned to first state his or her function followed by some questions about the knowledge level he or she has of Enterprise Architecture, the system landscape, the ONDL project, and a specific subject area of the ONDL project.

After that 5 questions are asked which will be discussed one by one. A total of 5 employees have been interviewed. One of them only filled in the half of the questionnaire and answered the other questions verbally. All with different functions like a project manager, a business consultant, an information manager, and a software designer. All interviewees except one consider themselves qualified to read architecture. One is also able to develop architecture. The average knowledge level, on a 1 - 5 scale, of the system landscape is 3.5, of the ONDL project is also 3.5, and of the changes that ONDL applies to masterdata management 3.

1. Does Enterprise Architecture help getting knowledge and insights in the system landscape? Explain your answer.

All of the interviewees answered the question with yes. The reason which comes forward in almost all answers is that Enterprise Architecture gives an excellent overview on the system landscape. One states that current documentation of the system landscape is text only. Another one adds that it depends on the different levels that are covered and the knowledge the reader already has.

2. Does Enterprise Architecture help getting knowledge and insights in the ONDL project and more concrete the changes it will apply to the system landscape? Explain your answer.

All of the interviewees answered the question with yes. One of the reasons given is that it visualizes the implementation which the reader has to do for himself if only written documentation is available. Furthermore the interviewees indicate that especially the difference between the 'as-is' and 'to-be' project architecture is easy to see.

3. Does Enterprise Architecture contribute to understanding the project documents? Explain your answer.

All of the interviewees answered the question with yes. One states that: "Architecture is at every level 'the overview', documentation gives the details." Others indicate that it helps understanding the global functional design project document. One is unsure whether or not Enterprise Architecture also contributes to project documents at a more detailed level than the global functional design.

4. Are there any other advantages or disadvantages of working with Enterprise Architecture that should be mentioned or looked into? Explain your answer.

There were a lot of different answers to this question. Multiple interviewees indicate that an advantage of Enterprise Architecture is that it can be a quick way to know and understand for the reader of the architecture unknown parts of the system landscape. This supposedly leads to more effectiveness during study phases of projects. One indicates that maintaining architectures and using standards is important. Another interviewee more or less says the same: "If discipline to maintain lacks, the value will decrease.".

5. Would you recommend working with architecture in other projects? Explain your answer.

All of the interviewees answered this question with yes. Most interviewees repeat or summarize earlier mentioned advantages of working with architecture. One states that: "Enterprise Architecture forces to look further than the parts that the projects cover. It makes the reader realize that there are relations between systems and that change in one system can have effects on other systems.". This answer can be best interpreted by stating that Enterprise Architecture forces people to take the bigger picture into account.

The questionnaire indicates that employees of Tata working with architecture are convinced that Enterprise Architecture can deliver the advantages it promises. The most mentioned advantages of Enterprise Architecture can be summarized as follows:

- Enterprise Architecture provides insight into the system landscape and business processes
- Enterprise Architecture visualizes the system landscape and helps better and quicker understanding of the project documents

- Enterprise Architecture can help speed up projects
- Enterprise Architecture can present the differences between the 'as-is' and 'to-be' situation of a project in an easy and understandable way
- Enterprise Architecture forces people to take the bigger picture into account

Whether or not Enterprise Architecture actually speeds up projects or improves the quality and value of project output can't be proven due to reasons mentioned before. What can be said is that architecture helps providing valuable insights and that nearly everyone working with architecture is convinced of its potential value.

The only thing the interviewees seem to worry about is the governance of architecture. They fear that when the developed architectures are not maintained properly that the value of working with architecture will decrease rapidly. The challenge for Tata will be implementing the required governance and architecture maintaining mechanisms. If they succeed, Enterprise Architecture at Tata Steel is bound to become a success.

6.   Conclusion and future work

Chapter 6 comes up with the conclusions and future work. The first paragraph, 6.1, briefly answers all the research questions and repeats the conclusions. Paragraph 6.2 discusses the future work.

6.1. Conclusions

This paragraph describes the conclusions of this thesis by summarizing the answers to all the research questions.

- Which approach has Tata chosen to work with Enterprise Architecture? Is this approach already completely defined? What can be improved?

Tata uses a TOGAF based architecture framework which is described and evaluated. This description along with some observations and improvements can be used by other organizations who wish to start their own EA initiative. Tata tries to customize the TOGAF approach to fit the organizations specific needs and uses the standards wherever possible. The approach is well defined and already quite mature. Nevertheless there is some room for improvement. In practice one of the most time consuming steps is developing the 'as-is' project architecture. The 'as-is' project architecture is missing in the approach. A proposal is done to define the 'as-is' as a deliverable on its own. The last point of criticism is on the compliance assessment and evaluation of the 'as-is' and 'to-be' project architecture. The evaluation and compliance checks are not clearly defined yet and a TOGAF template document is used for the wrong purpose. An interesting observation and conclusion is that the TOGAF Architecture Development Method isn't suited to be used for the development of project architectures.

- Up to which level of detail has Tata chosen to model using ArchiMate and at which point do they switch to other, for example not Enterprise Architecture related, techniques? Up to what level should an organization model?

The most difficult aspect of this research question was answering at what level of detail to stop using ArchiMate as the starting point is clearly the high level business processes. It is undoable to define a clear stopping point. Therefore the responsibility is given to the project architect. He or she should decide what level of detail is required for each project. When conditional statements need to be modeled BPMN can be a good alternative. One detail level above the conditional statement should be the lower limit to stop using ArchiMate.

- Is the subset of ArchiMate as specified in the "Tata Steel in Europe ArchiMate Meta model" sufficiently extensive to create the architectures for this project? Should an organization use an ArchiMate Meta model?

Organizations should most definitively use an ArchiMate Meta Model. It limits the complete ArchiMate language and helps an organization stimulating uniform modeling conventions. The Tata Steel in Europe ArchiMate Meta model proved to be sufficiently extensive and thus very well suited to create the architectures for the ONDL project.

- How should governance of architectural models be organized?

All project architectures should be connected to each other through domain and enterprise architectures. A repository should be used to store the architecture. A project checks out and checks in the relevant parts of the domain and or enterprise architecture that it is going to apply changes to.

Architecture deliverables should be checked on compliance to the standards and on the contents. Both steps are formalized in the compliance assessment which are required to formally finish the work on the 'as-is' and 'to-be' project architecture.

- Is the existing high level business description, referred to as 'thin-layer' suitable as a steppingstone for the architectures created within the ONDL project? Should an organization have an architecture that can be used as steppingstone?

The 'thin-layer' or domain architecture is perfectly suitable as a steppingstone for project architectures. A stepping stone or domain architecture should always be present for project architectures to connect to. This prevents project architectures to become scattered throughout the organizations and provides insight in which high level business processes will be affected by the project.

- Is the 'to-be' project architecture of the ONDL project compliant to the layer model as is standard within Tata?

Yes the 'to-be' project architecture is compliant. Almost all application components and business processes were part of level 5 of the Tata Steel reference model. A small number of application components were part of level 4.

- Tata Steel is an organization with its core business in producing steel. What observations can be done regarding working with Enterprise Architecture in such an industrial organization? Are there specific ways in which the architecture approach needs to be customized?

Industrial organizations tend to make use of a reference model. The Tata Steel reference model uses levels. Each level has its own closed control loop and only informs the level below and gets instructions from the level above. The approach needs to be customized in such a way that in the validation stages compliance to the reference model is checked.

- What are the advantages and disadvantages of working under architecture within the ONDL project?

All long term advantages as promised by literature are impossible to check because most are very hard to quantify and it would require monitoring the parameters over a longer period of years. The next best thing is to look at the advantages of executing the project under architecture. Because the project was put on a hold and executing, the already expensive project, under and without architecture obviously isn't an option, a questionnaire was created. All interviewees were positive over Enterprise Architecture.

The most mentioned advantages which users (developers or readers of architecture) experience are:

- Enterprise Architecture provides insight into the system landscape and business processes
- Enterprise Architecture visualizes the system landscape and helps better and quicker understanding of the project documents
- Enterprise Architecture can help speed up projects
- Enterprise Architecture can present the differences between the 'as-is' and 'to-be' situation of a project in an easy and understandable way
- Enterprise Architecture forces people to take the bigger picture into account

All interviewees recommend the use of architecture for this and future projects. The only thing they worry about is maintaining the architectures. They state that if the governance and or maintaining mechanisms fail the value of architecture will rapidly decrease.

The advantages that users experience or that they think architecture will deliver are also mentioned in literature sources that describe the advantages architecture should deliver.

The overall conclusion that can be drawn is that Enterprise Architecture has a lot potential. It still has to prove itself more over time but the experiences of users and the results of this thesis show that people are positive towards Enterprise Architecture and that working under architecture is of clear added value.

An important conclusion is that the Architecture Development Method of TOGAF isn't suited for project architectures. How to deal with project architectures is something that organizations need to find out themselves.

If Tata improves their architecture approach as suggested in this thesis and is able to implement proper governance and maintaining mechanisms nothing stands in the way for Enterprise Architecture to become a big success!

6.2. Future work

This paragraph describes the future work that could be conducted as a follow up on this thesis. The first and most obvious future work option is further research on the advantages or value of architecture. As mentioned in this thesis some advantages are hard to quantify and other variables need to be monitored for a longer period of time. More work and research is required on proving that Enterprise Architecture is actually able to deliver those advantages it promises.

Another option for future work is the motivation extension of ArchiMate. More research is required to determine whether this motivation should be used, what the advantages are, and how it should be incorporated in the architecture approaches or frameworks.

Appendix A: Compliance assessment

THE *Open* GROUP
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TATA

Compliance Assessment

Project ONDL as-is
Domain IJ-SLD

Table of Contents

Document Information

Project Name:	Project ONDL		
Prepared By:	Remco Ravenhorst	**Document Version No:**	**Error! Unknown document property name.**
Title:	Compliance Assessment	**Document Version Date:**	29-06-2011
Reviewed By:	Peter Strooper, Gert-Jan Kamer	**Review Date[1]:**	26-05-2011 06-06-2011

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0.1	27-05-2011	Gert-Jan Kamer	Draft version after 1st CA-meeting.	EA CA ONDL as-is
0.2	06-06-2011	Gert-Jan Kamer	Draft version after 2nd CA-meeting.	EA CA ONDL as-is
0.3	29-06-2011	Peter Strooper	Draft version	

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[1] The first date we reviewed up until topic 1.3; Transportprogramming

1.   Purpose of this Document

Once an architecture has been defined, it is necessary to govern that architecture through implementation to ensure that the original Architecture Vision is appropriately realized and that any implementation learning's are fed back into the architecture process. Period compliance reviews of implementation projects provide a mechanism to review project progress and ensure that the design and implementation is proceeding in-line with the strategic and architectural objectives.

At Tata Steel this will be done in iterations each existing of 3 steps:

1. Initial presentation by project architect. Maximum duration: 1.5 hours[2].

2. Feedback session by EA Assessment team, within 1 week after initial presentation.

3. Presentation of updated architecture products.

If step 3 appears to be insufficient, a new iteration will be started.

If sufficient the target architecture will be checked in in the repository.

Topics to be addressed in step 1:

1. Brief introduction in the topic.

2. Overview of the followed approach.

3. High level walk-through of deliverables.

4. Explanations of deviations from the standards.

5. What support was missing?

6. Learning's for next phases/other projects.

XMA, html or rtf should be sent 2 days before the meeting.

Text for 1 and 2 should be provided by project.

Topics to be addressed in step 2:

1. Findings and recommendations for improvement.

2. Clear overview of which steps are needed to get approvement.

---

[2] If more time is needed, an extra appointment should be made. Material for that session should again meet the mentioned deadline of 2 days.

2.   Initial presentation

2.1   Brief introduction in the topic

Remco: Lack of conditioned storage space is becoming more and more the bottleneck for production capacity at production site IJmuiden. In order to increase the maximum production capacity to 8 million tons a year a new distribution concept is developed. This distribution concept aims to move stock which is ready for transport from the site as quickly as possible. It is then stored close to the customer using hub and spoke principles. Implementing this distribution concept makes sure that lack of conditioned storage space doesn't limit the maximum production capacity anymore.

Peter: increase production capacity to 8 million tons will probably not happen anymore, and isn't the main trigger for the new distribution concept. But increase of tonnes / products that needs conditioned storage (north side of the IJmuiden site) is.

Other goals/benefits for LT are:

- decrease costs of storage & transport per ton by 'steady as it goes' ("rust & regelmaat")

- environmental (decrease finedust, noise) & safety objectives (lesser trucks on the site)
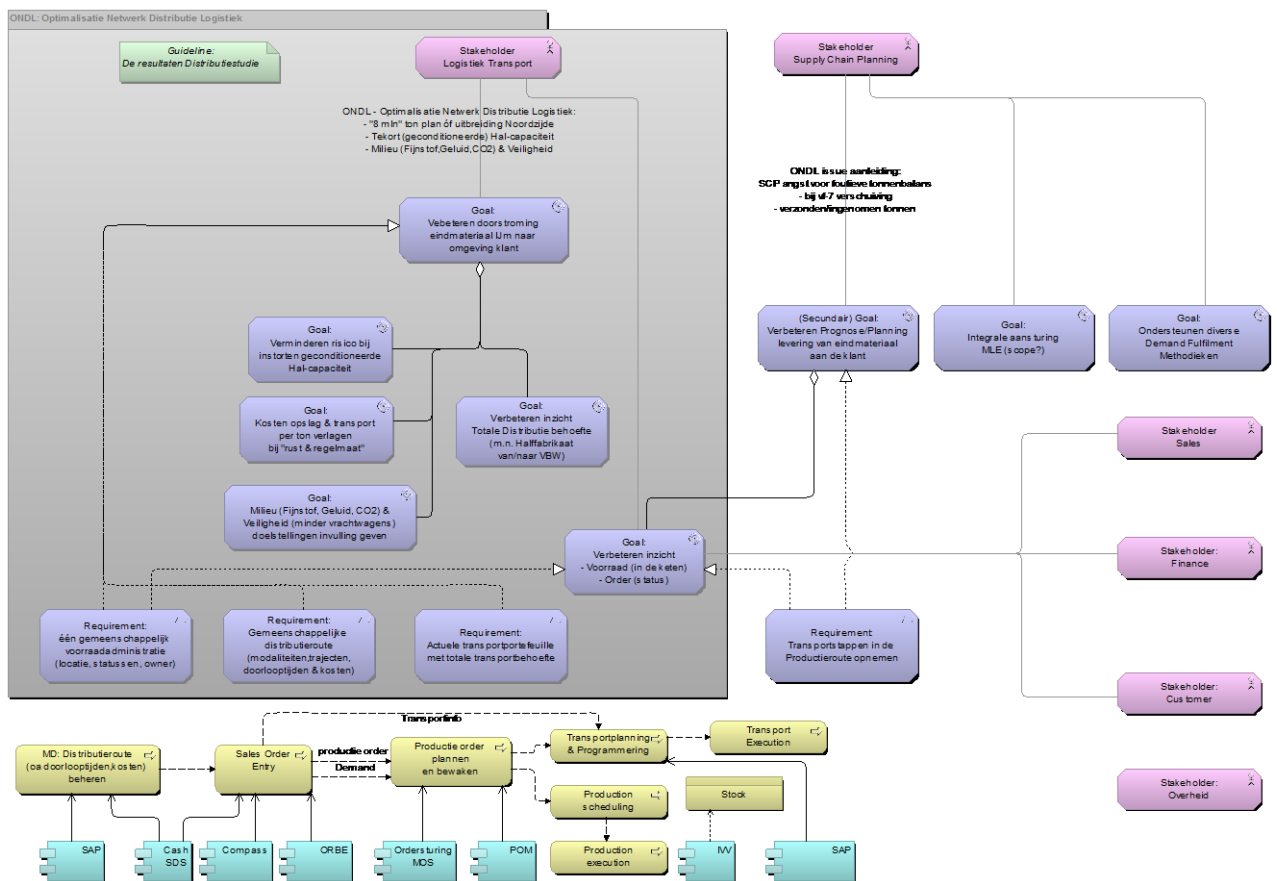
The current system landscape however isn't suited for the new distribution concept. The project ONDL, Optimalisation Network Distribution and Logistics, focuses on changing the current system landscape to allow it to work with the new distribution concept. A lot of processes and systems will be affected which makes ONDL a complex project.

2.2 Overview of the followed approach

Remco: In order to create the 'as-is' architecture extensive knowledge is required of the systems and processes that will have to be changed in the ONDL project. In order to properly understand these changes more general knowledge of the subject area also is required. At the start of the project I didn't have both.

The information I used to obtain the required knowledge came from several sources:

- BKC presentations (Company Knowledge Cycle)
- All kinds of (old) drawings of the system landscape, applications, and interfaces
- Multiple interviews with people from several departments
- Project specific: Werkwijzeverhaal
- Project specific: Globaal functioneel ontwerp. (Global functional design)

After having obtained enough information I started with a modelling the high level customer to cash process which I got from the interviews. This helped me getting experienced with the tool Architect and language ArchiMate as I had no experience, apart from the training course. Starting with this high level end to end process seemed a good starting point.

This starting pointed helped me to slowly start understanding the complex business processes and application landscape. The end result of the customer to cash architecture became the same as the already existing representation of the same process in the so called 'thin layer'. Nevertheless the efforts put into creating this architecture were not pointless. In fact these first steps proved of great value for gaining the general knowledge required to be able to understand the project specific changes to the system landscape.

Although these steps were of value the lack of knowledge also slowed the overall process down. Because I was unable to understand what would and what would not be part of the ONDL project I later found out that I was off track and modelling parts of the system landscape which proved to be almost completely irrelevant to ONDL.

After having gone through these steps I was able to get the focus more to ONDL. A choice was made to try to divide the work in a number of subject area's. This was done with help of the project documents werkwijzeverhaal and globaal functioneel ontwerp. This helped me to get, and stay, on track. It also helped searching and selecting people to interview as it became more specific. The quality of the 'as-is' architecture improved most during this last part of the approach were it became better with each iteration.

Issues regarding the modelling techniques and or principles I encountered during creation of the 'as-is' architecture I solved by discussing the issues with an ArchiMate (modelling language) and Bizzdesign Architect (modelling tool) expert. Some views required relations between concepts which aren't present in the Tata Steel in Europe ArchiMate Meta model. These deviations from the standards will be discussed in more detail in the next section.

Gert-Jan: Unclear was how Remco started: by copying the needed processes from the thin layer, or by adding new objects into the repository with similar/same names.

Peter: Unclear which criteria Remco had used to sort out the ONDL-relevant material and what is not relevant for ONDL visualisations. Model more on a higher level than too detailed level. But also stop modelling in earlier stage; work time-boxed with iterations.

Peter: the model only represents the as-is/current state. Not a to-be/future state. It was unclear (and sometimes still is) what functionality will be affected with the ONDL project. Some "scope creep" (not ONDL original goal related functionality) has influenced the ONDL project.

2.3 High level walk-through of deliverables

For this step we used the print-out version of the XMA sent to us by Remco dd 24-5 14:30.

Remarks mentioned here were done during the walk-through.

2.3.1   General remarks

- Currently we are not yet in a fully service oriented environment. Wouldn't it be wise to model the as-is state than with just existing services? That way it is clear, which components should be "upgraded" towards SOA.

- The "thin layer" was not yet available to the right level, that's why some aspects have been modelled as assumption.

- This project was already in a further project-phase than usually when a PSA is created: now even GFO was available, so relevant aspects could be deducted from deliverables, which usually will be created at a later stage.

- "…ing" (eg: "Updating Sales Contract") sounds a bit strange; use verb instead ("Update Sales Contract" or "Maintain Sales Contract").

- A (general) Master data view -ONDL specific- is missing, with aspects modelled like Distribution-Route,   Partner/Klant-verzending,   Distribution-Customer-Agreement,   Regio-indeling, Bufferafspraken, SAP-MD?!

2.3.2   Customer to cash

- Current view gives the impression all sub-processes are triggered ánd are done in sequential order.

- Missing: what are the focus-areas for this project. (Use call-outs?)

2.3.3   Process Customer Order

- Application-service layer may be of some use for the domain-architecture, but is not relevant to this project.
  Appl-services is important to me!
  And/or make a separate application view, with application-services as coupling/decoupling point.
  And only draw c.q. decomposite those application-service which are relevant for ONDL.

- Application-service "Retrieve Masterdata" is too generic. Please mention what kind of Customer, Product, Pricing, Agreement masterdata is being used.
  Application-service "Retrieve Masterdata" is not a decomposition of "Sales Order Creation", but
  - or is being used-by appl-service "Sales order Creation"
  - or is being used-by appl-comp "Compass (Order Entry)"

- From the application Compass downward in the view it is ONDL-related.

- Sales Order Booking should be modelled as a component; the sub-functions better as internal services.
  For me the only relevance for ONDL is: that the application-comp "Compass (Order Entry)" uses the appl-service "Retrieve Distribution Agreement (DKA)" from SDS-datastructure.

- The term "Planned Distribution Route" gives the wrong impression (read: is the **to-be** state): it actually currently is an orderpost with DKA and "roepnaam-verzending".
  On more places, I got the feeling the **to-be** ONDL state is modelled, instead the **as-is** state.

- The English term " Call Sign Shipping" for "Roepnaam-verzending" does not work. ("Woordenlijst" needed). I prefer "Ship-to" (SAP-term) for "Verzend-Naar" and "Consignee" for "Klant-verzending".

Note that "Roepnaam-verzending" is the (key-)Attribute of Entity "Klant-verzending". And it is better to use Entity-names than Attribute-names.

- App.Service "Create/Update SAP order" should be triggered by an event like "It is sure this order will be launched".
  In other words: What (automatic?) process triggers "SAP-SD / Create SAP-order" ?
  In my opinion: If the Sales Order is validated; a automatic night/morning-batch is running to automatically create SAP-orders and SAP-deliveries. (everything in the blue layer)
  Strange that 'internal' service "Create / Update SAP-order" is used-by appl-comp IVV; you probably meant a interface or something?

2.3.4 Transport planning

- What is the event that triggers Transportplanning? Probably "TCS gemaakt".

- "LT Customer Book" is only used within the process "Transportplanning & Transportprogramming", and is therefore modelled within this process, whereas the standard says it should always be modelled outside. Acceptable in this case, because it clearifies the use of the object.
  "LT Customer Book" is Masterdata of LT, in the XLS-form.

- What is "Booking Letter" ?

- Are Transportcosts part of Transportplanning?
  Because reduction of storage & transport costs is one the goals of ONDL.

- Blue layer: Compass provides Customer data & (transport) Order data
  Shouldn't there be a 'internal' appl-service(s) between Compass/ORBE/IVV and ISMPL? (see 2.4 remark: this is acceptable)

- Within SAP-SD a shipment is created, but what about the relation with the underlying deliveries?

2.3.5 Transport programming

- Too many processes/applications in one view; you want to tell too much in this view.
  May have to be adjusted after discussion on "verzendgereed". Now it seems to represent 2 events in one view: "verzendgereed" ánd programming.

- Seems to be very (too?) detailed. Difference in detail-levels.

- "Taking care of documents" seems an odd process-name. Furthermore:

  o are these documents input or output to this process?

  o Is this process really triggered by "Programming Stock"?

  Appl-comp DUS system is used for Documents output.

- Service-on-service seems a bit strange (see: "Booking Stock which is read for sending"; can't it be modelled as the name of the relation to "Stock released for transportation"?

- Sometimes arrows are modelled unclear; eg between "Collo table" and "Collo Call".

- Shouldn't there be application components or interfaces between Shipment and Delivery and the IVV-services?

- After explanation it appears ok to model a trigger related to a service by a used-by relation, but we don't put it in the standards.

2.3.6 Maintain SLD Masterdata

- See the general remark

- Shouldn't all processes which are not specified at a deeper level be connected to at least one object?

2.3.7 Maintain Partner Masterdata

- Definition-file would be needed for clear understanding (eg: "Call Sign Shipping").

- Remco will discuss this view in more detail with Richard Willemse.

2.3.8 Maintain Sales Contract Masterdata

- Please replace this view with a view of "Sales Contract" processes and Applications objects which are relevant for ONDL. E.g. Maintain Distribution Customer Agreements within Cash. Or maybe only the result in the form of info/data-object "Distribution Customer Agreement".

- The data-objects which are maintained by function (should be application-component) "Updating Sales contract".

- The CASH-services seem to be interfaces: model as interface.

- Discussion on CASH-SDS: see chapter 2.4.

2.4 Explanations of deviations from the standards

This section describes the deviations from the Tata Steel in Europe ArchiMate Meta model.

- Transportplanning: Between Compass/ORBE/IVV direct flows have been modelled to ISMPL, where a service should be put between them. But since this picture clearifies it better, it is accepted.

- Application service with an access relation to a Data Object

  Application service "CASH-SDS" update has an access relation (here: write) to Data Object "Distribution Customer Agreement". This is a short and clear way of modelling while keeping the focus on the, for this project, relevant concepts. In reality there exists an application component which realises this service. Acceptable in a view ("vervangende relatie"), but the repository should hold the relations via application componenten.
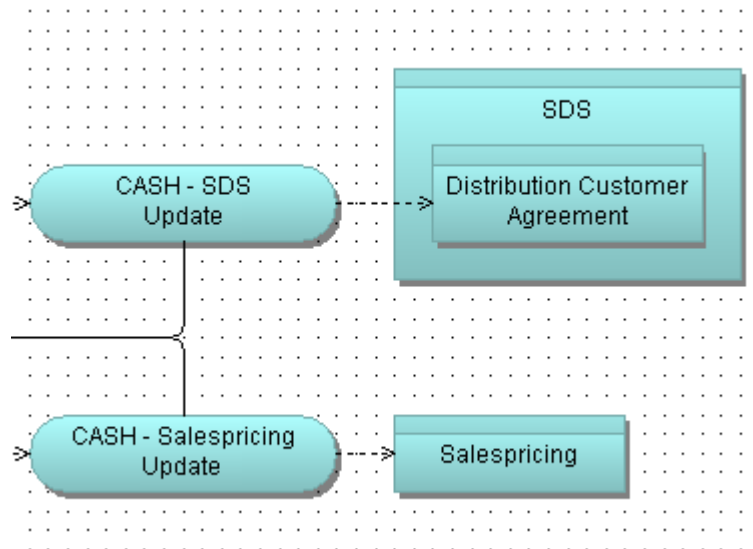
2.5   What support was missing

- Remco: The development of the 'as-is' architecture could have gone faster if I'd understood the existing 'thin-layer' better in the beginning. Understanding the 'thin-layer' provides the project architect with essential general knowledge of the business processes and the application landscape. Required to understand the project specific changes. Now I had to find out myself. Although finding out yourself may be the best way of learning and understanding the system landscape this certainly isn't the quickest way. Preventing the project architect from going off track would reduce the time it takes to create project architectures.

- Hands on support, but since Remco shared a room with Rob Kroese, he sometimes consulted Rob.

2.6   Learnings for next phases/other projects

- When describing the to-be, it may appear certain aspects should be added to the as-is. How should this be governed?

- For presentation-purposes it is considered useful to have a beamer available for the meeting. (Or a screen for a 1:1 session.)

- Remco: Evaluation of the approach teaches that it is easy to get off track. If the project architect is inexperienced, and has no background knowledge of the process and application landscape, efforts should be made to make the architect stays on track. This prevents situations in which the project architect is modelling area's of the system landscape which are irrelevant for the project. Besides that the approach and support seem right.

-

2.7   Additions/changes to the standards

- Draw a result as a mirrored event. (NB: This standard was introduced by this project, but not always modelled this way=>adjust.)

- Make clear what we (ACC) consider Masterdata, and what not. Disputable: Product specifications. This is not a Modelling Standard change, but could be more a (soft) guideline.

- How should we deal with: If only certain attributes of an entity are relevant; how to model this?
  This is not a Modelling Standard change, but could be more a (soft) guideline.

- Can/should we state naming-conventions for entities, like: start with "MD" when it is a Master Data object. In my opinion: no. All naming-conventions should be functional/logical and self explainable. Experience already learns to keep away form prefix or suffixen as suggested.

- Make a clear statement on when to use "tijdpad" and when not. I do not understand this?

Extra[3] actions

Topic	Explanation	Who	Ready
Definitions	Remco has got a list of definitions which he used for the project. Send this to GK/PS.	RR	
Used by vs read/write	There should be a generic rule to explain when to use "used by" and when "read/write".	PS	
Model within a proces	Make very clear in which case objects like contracts and business-objects should be modelled within a process.	PS	

---

[3] Not all actions from the text are repeated here; detailed actions should be derived from the text.

Appendix B: EA Questionnaire results

Value of Enterprise Architecture for ONDL		
Function	Software Designer	
Knowledge in and experience with EA	Inexperienced	
	Has some knowledge of EA	
	Can read architecture	
	X Can create / develop architecture	
Knowledge level of system landscape	(1-5)	3
Knowledge level of ONDL project	(1-5)	3
Knowledge level of changes ONDL applies to masterdata management	(1-5)	3

	Question	Answer
1.	Does Enterprise Architecture help getting knowledge and insights in the system landscape? Explain your answer.	Yes

It depends on the different levels that are covered and the knowledge the reader already has. Besides that, yes.

	Question	Answer
2.	Does Enterprise Architecture help getting knowledge and insights in the ONDL project and more concrete the changes it will apply to the system landscape? Explain your answer.	Yes

Especially the difference AS-IS / TO-BE is easy to see.

	Question	Answer
3.	Does Enterprise Architecture contribute to understanding of the project documents? Explain your answer.	Yes

GFO level, yes. More detailed level, maybe

	Question	Answer
4.	Are there any other advantages or disadvantages of working with Enterprise Architecture that should be mentioned or looked into? Explain your answer.	Yes

Maintaining the info and using the standards is very important. Adv: quick way to get to know a system or part of system.

	Question	Answer
5.	Would you recommend working with architecture in other projects? Explain your answer.	Yes

EA forces to look further than the parts that the projects cover. It makes the reader realize that there ~~are~~ are relations between systems and that changes in one system can have effects on other systems.

Value of Enterprise Architecture for ONDL		
Function Business Consultant Supply Chain management		
Knowledge in and experience with EA	Inexperienced	
	Has some knowledge of EA	X
	Can read architecture	
	Can create / develop architecture	
Knowledge level of system landscape	(1-5)	3
Knowledge level of ONDL project	(1-5)	3
Knowledge level of changes ONDL applies to masterdata management	(1-5)	3

	Question	Answer
1.	Does Enterprise Architecture help getting knowledge and insights in the system landscape? Explain your answer.	yes
	Yes, a good picture gives the basis to develop knowledge.	
2.	Does Enterprise Architecture help getting knowledge and insights in the ONDL project and more concrete the changes it will apply to the system landscape? Explain your answer.	yes
	yes, the changes are ~~visible~~ visible and documented.	
3.	Does Enterprise Architecture contribute to understanding of the project documents? Explain your answer.	yes
	Combining the detailed GFO with the pictures will help to get a more grip.	
4.	Are there any other advantages or disadvantages of working with Enterprise Architecture that should be mentioned or looked into? Explain your answer.	yes.
	Advantage: helpful to understand unknown parts of the system landscape → more effectiveness during study phases of projects. Disadvantage: If discipline to maintain lacks then the value will decrease.	
5.	Would you recommend working with architecture in other projects? Explain your answer.	yes.
	Given discipline to maintain then it will help to get useful insights that will increase effectiveness.	

Value of Enterprise Architecture for ONDL			
Function			
Knowledge in and experience with EA	Inexperienced		
	Has some knowledge of EA		
	Can read architecture		✓
	Can create / develop architecture		
Knowledge level of system landscape	(1-5)		4
Knowledge level of ONDL project	(1-5)		3
Knowledge level of changes ONDL applies to masterdata management	(1-5)		4

	Question	Answer
1.	Does Enterprise Architecture help getting knowledge and insights in the system landscape? Explain your answer.	yes.

Current documentation is in text only, this schemas
gim Excelat overview, and different flow's ~~are~~ are clear.

2.	Does Enterprise Architecture help getting knowledge and insights in the ONDL project and more concrete the changes it will apply to the system landscape? Explain your answer.	yes

Same. argumentation as in 1. a picture is more
than 1000 words, ~~It helps making~~ it visualize the
implementation. In ~~text~~ ~~death~~ written documentation the reader
has to visualization himself.

3.	Does Enterprise Architecture contribute to understanding of the project documents? Explain your answer.	yes

Architecture is at every level "the overview", documentation
gives the details.

4.	Are there any other advantages or disadvantages of working with Enterprise Architecture that should be mentioned or looked into? Explain your answer.	?

5.	Would you recommend working with architecture in other projects? Explain your answer.	yes

• It gives an excelas overview,
• It has a standard, ~~so every structure~~.
• once. introduced an accepted, document can be
used in maintenance phase.

Value of Enterprise Architecture for ONDL			
Function			
Knowledge in and experience with EA	Inexperienced		
	Has some knowledge of EA		
	Can read architecture		
	Can create / develop architecture		✗
Knowledge level of system landscape	(1-5)	4	
Knowledge level of ONDL project	(1-5)	4	
Knowledge level of changes ONDL applies to masterdata management	(1-5)	3	

	Question	Answer
1.	Does Enterprise Architecture help getting knowledge and insights in the system landscape? Explain your answer.	Yes.
2.	Does Enterprise Architecture help getting knowledge and insights in the ONDL project and more concrete the changes it will apply to the system landscape? Explain your answer.	
3.	Does Enterprise Architecture contribute to understanding of the project documents? Explain your answer.	Yes
	Yes, connections between different parts become more apparent.	
4.	Are there any other advantages or disadvantages of working with Enterprise Architecture that should be mentioned or looked into? Explain your answer.	
5.	Would you recommend working with architecture in other projects? Explain your answer.	yes.
	Great help in communication ~~between~~ among project members.	

Value of Enterprise Architecture for ONDL		
Function	Project Manager / Information Manager	
Knowledge in and experience with EA	Inexperienced	
	Has some knowledge of EA	
	Can read architecture	X
	Can create / develop architecture	
Knowledge level of system landscape	(1-5)	4
Knowledge level of ONDL project	(1-5)	5
Knowledge level of changes ONDL applies to masterdata management	(1-5)	~~5~~ 4

	Question	Answer
1.	Does Enterprise Architecture help getting knowledge and insights in the system landscape? Explain your answer.	Y

Het maakt inzichtelijk welke ~~systeem~~ proces wordt ondersteund door welke informatiestromen/systemen. Dit ~~geeft~~ is mn de "handig" bij doorvoeren van wijzigingen omdat den impact beter kan worden ingeschat

| 2. | Does Enterprise Architecture help getting knowledge and insights in the ONDL project and more concrete the changes it will apply to the system landscape? Explain your answer. | Y |

zie boven.

| 3. | Does Enterprise Architecture contribute to understanding of the project documents? Explain your answer. welke ng | Y |

Een plaatje zegt meer dan 1000 woorden!

| 4. | Are there any other advantages or disadvantages of working with Enterprise Architecture that should be mentioned or looked into? Explain your answer. | Y |

De verschillende views maakt het gemakkelijker te communiceren ~~met~~ op verschillende niveau's

| 5. | Would you recommend working with architecture in other projects? Explain your answer. | Y |

Impact wordt beter begrepen.
Maar men moet wel weet hebben van EA.

) Nadeel: nog relatief onbekende methodiek.

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