Universiteit Leiden

ICT in Business

Interorganizational enterprise architectures

The introduction of a model on interorganizational collaboration

Name: Eric Rijnboutt
Student-no: 1282085

Date: 06/06/2014

1st supervisor: Drs. B. Kruiswijk
2nd supervisor: Dr. H.T. Le Fever

MASTER'S THESIS

Leiden Institute of Advanced Computer Science (LIACS)
Leiden University
Niels Bohrweg 1
2333 CA Leiden
The Netherlands

Master's thesis

Universiteit Leiden
LIACS - Leiden Institute for Advanced Computer Science

Student ID: 1282085

First supervisor: Drs. B. Kruiswijk
Second supervisor: Dr. H.T. Le Fever

External supervisor: Drs. J.M.J. Riemens

This thesis was written from the personal perspective of the author. The people interviewed for this thesis also gave their personal view on the subject, and these views therefore doesn't necessarily have to match the vision of the organization they work for.

Preface

This master's thesis is written as the final project for the master ICT in Business. It is the result of a very instructive project at a modern and dynamic organization.

The document is written for people who are interested in using enterprise architecture in a broader scope. Board members, (IT) managers and architects will probably recognize situations from their own organizations and could therefore find this thesis very useful.

The first part of the document is an analysis on interorganizational architecture, including the introduction of a model on interorganizational architecture types. This model is used in the second part, being a case study at Brandweer Hollands Midden. The final chapter can be seen as a conclusion giving general principles on the use of interorganizational architecture.

Without the time made available by several people this thesis couldn't have been written. I would like to thank the people I could interview and all other people that helped me write this thesis. Special thanks to my supervisors Marijn Riemens and Bas Kruiswijk for their useful feedback and support. Finally I would like to thank Brandweer Hollands Midden for the opportunity to write my thesis and the great time I had working there.

Eric Rijnboutt

Leiden, June 2014

Contents

Summary

This thesis is about enterprise architecture (EA) that focuses on more than one enterprise or business unit: interorganizational enterprise architecture. The main research question is: when should organizations use interorganizational enterprise architecture, and what should it consist of? The subquestions focus on the exploration of the subject, an advisory case study at Brandweer Hollands Midden, and the introduction of general principles related to the topic.

For this research related literature was combined with interviews at various organizations that already make use of some type of interorganizational architecture. Different models related to traditional enterprise architecture are used to analyze the different possibilities of interorganizational architecture, like the DYA model by Sogeti and the ATHENA Interoperability Framework.

There are several possible drivers for collaboration, of which some also lead to drivers for the use of interorganizational architecture. Different types of collaboration can influence the type of architecture used. From different perspectives on interorganizational architecture, three were chosen to be included in a model on interorganizational EA. This model consists of a quadrant with the axes 'diverse vs. similar organizations' and 'autonomy retained vs. central authority in place'. The different architecture types in the model are chain architecture (diverse, autonomy), sector architecture (similar, autonomy), segment-based architecture (diverse, central authority) and the authority-based architecture (similar, central authority). The well-known reference architecture can be placed behind this quadrant, being the less specific type of architecture. The model should be seen as a continuous space with the quadrants as 'extremes' for each combination on the two axes. The characteristics of the different types of architecture strongly differ, which makes them only suitable in certain situations.

Brandweer Hollands Midden is one of the regional fire service organizations in The Netherlands. It is part of the safety region VRHM and is involved in a lot of cooperations. The question is raised if and with whom interorganizational architecture should be used. An analysis of the current situation shows some difficulties in the collaborations with partners inside and outside the VRHM. The main results BHM is looking for are better cooperation with partners and saving money. These could be reached by looking at improving the interoperability, information integration and aligning business processes.

After using the model on interorganizational architecture for analyzing the different possibilities for BHM, the advice would be to create an segment-based architecture within the VRHM to improve the interoperability between the partners. Second, a sector architecture could be used to support the primary processes within the fire service sector. This could be done with a national scope to improve the alignment within the sector. Introducing these architectures would have some impact on the current situation, and it is therefore required for the management to understand the possible value of enterprise architecture.

Based on the various analyses conducted in this thesis general principles are given that can be used by architects or (information) managers in all industries. These principles focus on the when and why question regarding interorganizational EA, as on the questions 'with who' and 'what should it consist of'.

Managementsamenvatting

Samenwerking met andere partijen is van groot belang voor organisaties als Brandweer Hollands Midden (BHM), en niet alleen in crisissituaties. Het op de juiste plek beschikbaar hebben van de juiste informatie op het gewenste moment kan van levensbelang zijn. Daarnaast is het belangrijk om bedrijfsprocessen op elkaar aan te laten sluiten en werkwijzen met elkaar te integreren. Standaardisatie kan daarbij een grote rol spelen. Enterprise architectuur kan helpen deze doelen te bereiken.

Enterprise architectuur (EA) is een beschrijving van bedrijfsprocessen, applicaties en de door deze geleverde diensten, en de IT infrastructuur binnen een organisatie. Vaak bestaat een architectuur uit platen (overzichtstekeningen) en bijbehorende beschrijvingen en inrichtingsprincipes. Een architectuur wordt gebruikt om de samenhang van deze verschillende onderdelen binnen een organisatie weer te geven, en dient als leidraad voor toekomstige ontwikkelingen. Waar traditionele EA voornamelijk de (gewenste) situatie binnen één organisatie beschrijft, kan de scope ook worden verbreed naar meerdere (samenwerkende) organisaties: organisatieoverschrijdende enterprise architectuur.

Het onderzoek
Deze scriptie beschrijft de mogelijkheden van organisatieoverschrijdende enterprise architectuur en bevat een case study binnen BHM. Een advies met betrekking tot het gebruik van een dergelijke architectuur geeft antwoord op de vraag: 'Wat is de toegevoegde waarde voor Brandweer Hollands Midden van het gebruik van organisatieoverschrijdende enterprise architectuur?'

Aan de hand van literatuur en interviews met verschillende partijen wordt een model geïntroduceerd dat verschillende typen architectuur beschrijft (zie figuur 0.1). De assen geven aan in hoeverre de architectuur gericht is op gelijksoortige of diverse organisaties, en of de autonomie behouden blijft dan wel (gedeeltelijk) opgegeven wordt. Het model moet worden gezien als een continu vlak, wat betekent dat een bepaalde architectuur ook tussen meerdere soorten in kan zitten. Een referentiearchitectuur (zoals de NORA en de VeRA) is een minder specifiek type, en wordt vaak gebruikt als basis voor een specifiekere architectuur. Elke type architectuur heeft voor- en nadelen, en is meer of minder geschikt afhankelijk van de situatie.

De casus
Brandweer Hollands Midden maakt deel uit van de veiligheidsregio VRHM en is daarnaast ook betrokken in andere samenwerkingsverbanden zoals met andere regionale brandweerkorpsen, de meldkamers, de RUD's etc. Zowel binnen de veiligheidsregio als daarbuiten speelt samenwerking een cruciale rol bij de uitvoering van de wettelijke taken. In zowel koude als warme situaties dient de juiste informatie beschikbaar te zijn. In de huidige situatie zijn gevallen te onderscheiden waarbij efficiënter gewerkt zou kunnen worden. Dit komt de informatievoorziening ten goede, en kan ook een kostenbesparing met zich meebrengen.

Binnen de VRHM is de keuze gemaakt om de verschillende disciplines autonoom te laten functioneren en deze te ondersteunen met een kleine veiligheidsregio. Dit betekent dat informatiesystemen in beheer

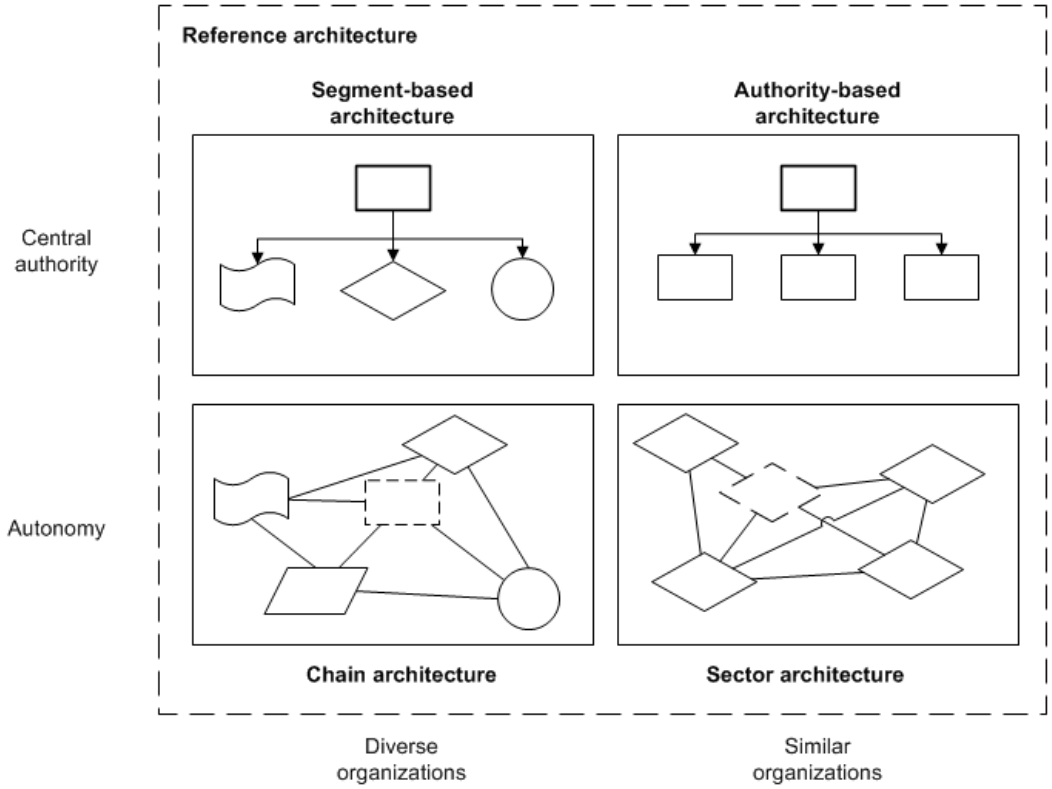

Figure 0.1: Het model over organisatieoverschrijdende enterprise architectuur

zijn bij één van de disciplines. Het gezamenlijk gebruik van deze systemen wordt hierdoor beperkt. Een systeem met geo-informatie zou bijvoorbeeld door meerdere partners gebruikt kunnen worden. Natuurlijk vraagt dit om een ander ontwerp en inrichtingsproces, en ontstaat de vraag wie zulke systemen moet gaan beheren.

Via multi-werkgroepen en multi-afdelingen van BHM worden de werkzaamheden die input van meerdere disciplines vragen opgepakt. De werkgroepen hebben echter alleen een adviserende rol. Samenwerking binnen multi-processen verloopt soms niet zo efficiënt en effectief als mogelijk doordat het delen van documenten (informatie) niet op het juiste moment plaatsvindt. De verschillende disciplines weten niet altijd van elkaar wat er opgeschreven wordt (bijvoorbeeld in het proces van advisering), wat betekent dat dit later weer gecorrigeerd moet worden.

Ook buiten de VRHM kent Brandweer Hollands Midden verschillende partners waarmee samen wordt gewerkt. De regionale brandweerorganisaties worden deels gefaciliteerd door Brandweer Nederland. Samenwerking tussen de verschillende regio's is echter niet structureel. Kennis- en informatiedeling vindt plaats wanneer er een gerichte vraag is, terwijl het structureel delen van informatie bij kan dragen aan een betere brandweerorganisatie. Hiervoor is het vereist dat er enige vorm van standaardisatie wordt bereikt binnen de sector.

Advies
Ook met de huidige ontwikkelingen zoals LMO/NMS en de vorming van de nationale politie in het hoofd is er een advies gevormd voor Brandweer Hollands Midden / de VRHM. Dit advies bestaat uit twee delen en focust voornamelijk op de toepassing van enterprise architectuur. De situatie zoals geadviseerd is weergegeven in figuur 0.2

Een sterkere veiligheidsregio kan bijdragen aan een betere informatievoorziening en -deling. Een centrale

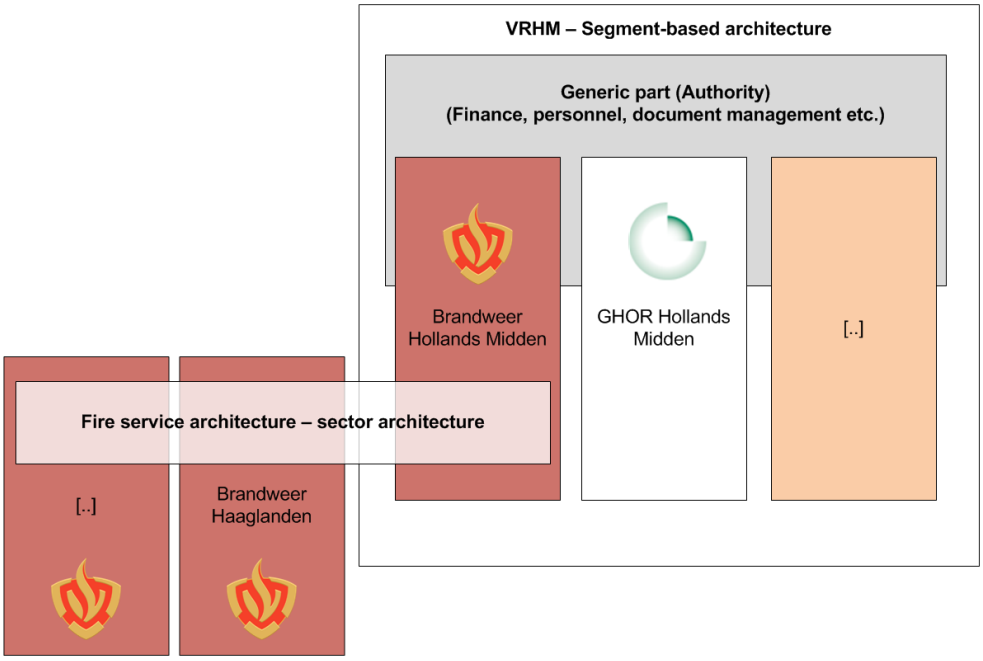

Figure 0.2: Een visualisatie van het architectuuradvies

autoriteit die generieke processen beheert en stuurt op samenwerking en standaardisatie binnen de veiligheidregio kan ervoor zorgen dat informatie centraal beschikbaar komt en beheerd wordt. De verschillende disciplines kunnen zich (autonoom) richten op de taakspecifieke processen en kunnen hierbij gebruik maken van centrale informatiebronnen. Multi-werkzaamheden kunnen beter worden ondersteund door gebruik te maken van centrale applicaties voor zover als dat mogelijk is. Deze manier van werken kan een hoop tijd en geld besparen.

Binnen de landelijke brandweerorganisatie kan ook gebruik worden gemaakt van een architectuur. Doordat (bijna) iedere regionale brandweer onderdeel is van een veiligheidsregio, is het van belang dat een dergelijke brandweerarchitectuur zich richt op de specifieke brandweertaken en processen. Standaardisatie van processen en gegevens draagt bij aan een betere samenwerking en maakt het makkelijker om informatie te delen, ook in warme situaties.

Om ervoor te zorgen dat de introductie van de genoemde architecturen ook de beoogde resultaten biedt, is het noodzakelijk dat het management en betrokken afdelingen het nut van architectuur kennen en de ontwikkelingen steunen. De invoering van een architectuur vraagt tijd en inzet, en verliest snel zijn waarde als de betrokken partijen niet meewerken.

Het laatste hoofdstuk van deze scriptie bevat algemene principes met betrekking tot het gebruik van enterprise architecture over organisatiegrenzen heen, en geeft antwoorden op de ‘wie, wanneer, wat en waarom’ vragen. Deze principes kunnen door architecten en managers gebruikt worden wanneer gekeken wordt naar de mogelijkheden van organisatieoverschrijdende architectuur, ook in andere situaties of sectoren dan die van Brandweer Hollands Midden.

Chapter 1

Introduction

Enterprise architecture is an upcoming topic within a lot of organizations. The amount of literature about it is also increasing. The next step when it comes to architecture within an organization is to try to extend it across organizations. In this chapter, the research conducted will be introduced, by giving a basis for the rest of this thesis.

The main research question is introduced in section 1.1, followed by the relevance of the study in section 1.2. Section 1.3 will introduce the case study conducted at Brandweer Hollands Midden. The last part of this chapter, section 1.4 will give a short theoretical background related to the topic.

1.1 Research

In this section the research conducted for this thesis will be explained. Next to introducing the main research question and the related subquestions, the followed plan will be discussed and the used methods are illustrated.

1.1.1 Research question

The field of enterprise architecture primarily focuses on architecture within one organization. In today's world though, a lot of organizations, or divisions of organizations, work together or are linked with others to combine capabilities and get the most out of their bundled resources.

Using enterprise architecture to model and implement these partnerships is something new. Looking into the current literature, there appear to be a lot of different views on the issue. A structured overview of the possibilities and results is not present though.

The research done for this thesis focuses on the use of interorganizational enterprise architecture. It is unclear for most managers if and why they should use architecture to facilitate collaboration with business partners. This research focuses on answering some of the questions regarding this topic. The main research question is formulated as follows:

> ***Research Question:*** *When should organizations use interorganizational enterprise architecture, and what should it consist of?*

This question thus includes questions like 'when', 'what', 'with who', and 'why'. The main focus though is on the content of such an architecture. The processes on how to get there or how to use it once you created it are outside the scope of this thesis.

1.1.2 Subquestions

The main question is split up into three subquestions. These subquestions all have their own focus area, and a distinctive goal. Altogether, they aim to provide an answer to the main research question.

> ***Subquestion 1:*** *What is interorganizational enterprise architecture, and what types exist?*

There is no clear view on what an interorganizational architecture exactly is, what types there are or what these types contain. This part of the research tries to come up with a structured overview of the possible types of interorganizational architectures, and related insight on when to choose a specific type and how it could benefit the organization(s).

For this part of the research, two types of information gathering were used (see picture 1.1). Qualitative literature research was the primary source of information. Literature on interorganizational enterprise architecture and related topics was analyzed and used to identify different perspectives on the issue. These perspectives formed the basis of the model on interorganizational architecture that will be introduced in section 2.2. The literature research was supported by interviews. These interviews were semi-structured interviews with people from various organizations that already use some form of interorganizational architecture. The different types of architectures that came up during the interviews were used as input and validation of the model introduced.

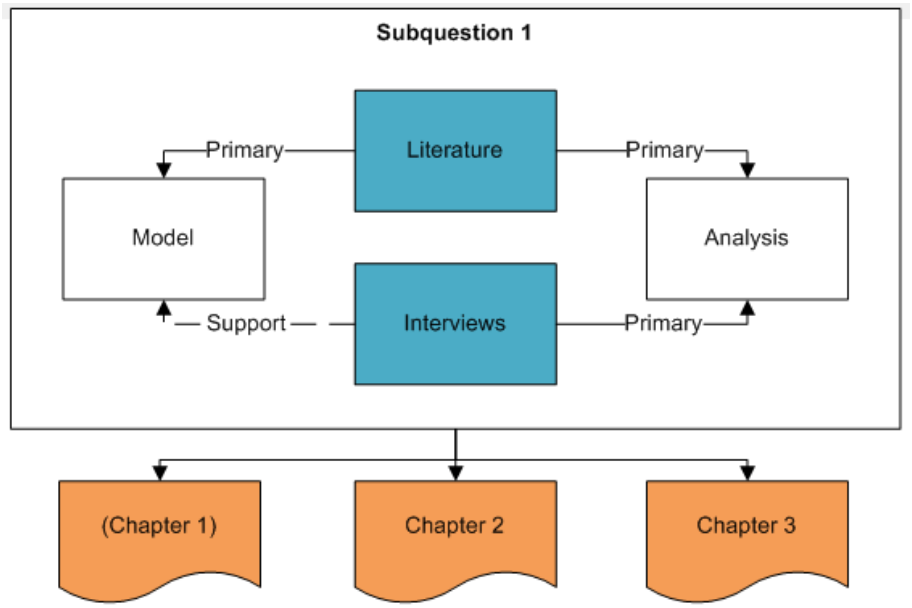

Figure 1.1: Research approach subquestion 1

For the analysis of the model, the interviews were combined with literature on specific cases. The interviews primarily focused on the drivers for an interorganizational architecture, the content of the architecture, and the envisioned and proved benefits of it. The interviews were transcribed, tagged and analyzed. Tagclouds were formed combining the data of the several interviews. Additionally, data acquired from literature on specific cases of interorganizational architecture was also put in the same tagcloud, to increase the size of the dataset. The results described in the analysis are derived from this dataset, supported by literature.

An example of a transcription of one of the interviews as well as the tagclouds can be found in appendix

A.

The next subquestion focuses on a specific case. The model on interorganizational architectures is used in practice for this question.

> ***Subquestion 2:*** *What is the added value for Brandweer Hollands Midden of using interorganizational enterprise architecture?*

The knowledge gained during the first part of the research is applied during a case study at Brandweer Hollands Midden, one of the regional fire service organizations in The Netherlands. This case study is further introduced in section 1.3. The information used for answering this question consists of related literature, interviews with people who are concerned with the organization or linked organizations, and the results of the first subquestion (primarily the model introduced). An overview is depicted in figure 1.2.

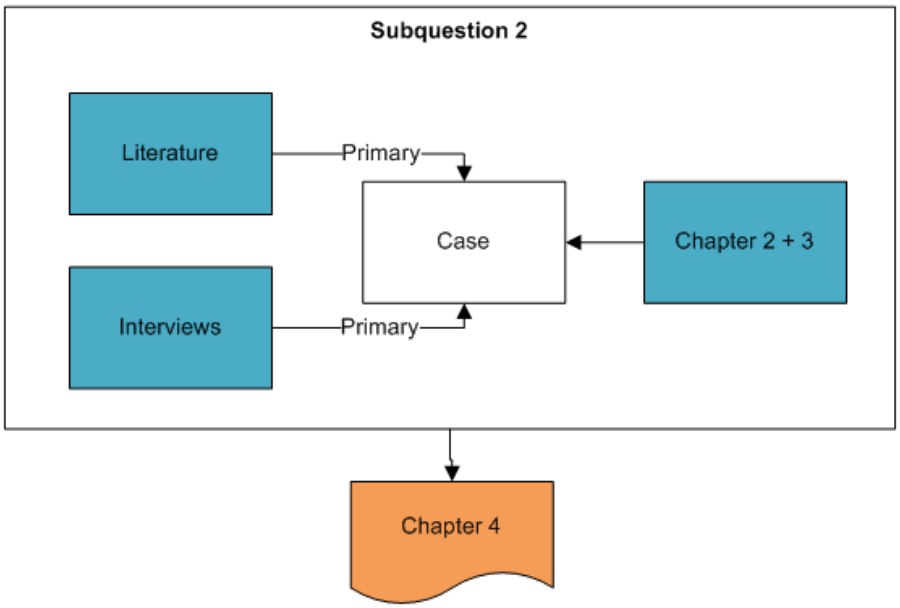

Figure 1.2: Research approach subquestion 2

After answering above-mentioned two subquestions, the results are combined to form a synthesis.

> ***Subquestion 3:*** *What general principles can be used in the decision-making process regarding the use of interorganizational enterprise architectures?*

For this research to be useful for (IT-)managers in all sorts of organizations, general principles are introduced that can be used in case an organization is looking into the use of interorganizational enterprise architecture. These principles will mainly regard questions like ‘when’, ‘with who’ and ‘what to put into it’. The process of how to actually design and implement such an architecture is outside the scope of this question. The input for this question mainly comes from the previous research questions. Additionally, it is supported by literature and interviews (see figure 1.3.

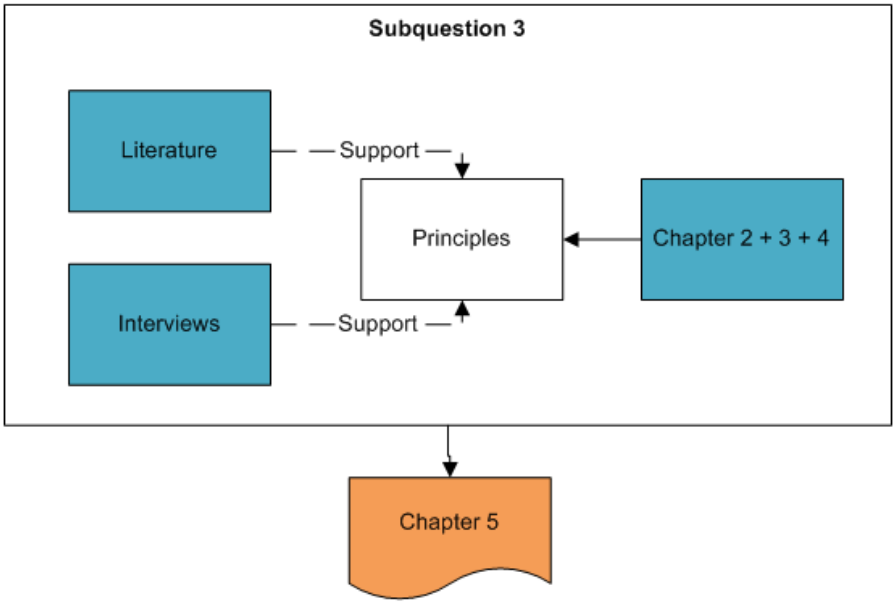

Figure 1.3: Research approach subquestion 3

1.2 Relevance

A lot of organizations are working together with partners within the same sector, or even with organizations outside their own sector. The goals they have for setting up the cooperation may also be different. To facilitate in the process of setting up a good basis for this cooperation, enterprise architecture (EA) is extended across multiple organizations.

One of the main problems when looking into ways to do this, is the terminology used. Different authors who have written about using EA across organizations use different words in describing different possibilities and solutions. This makes it hard to integrate information and get the knowledge you need.

Another problem is that extending enterprise architecture across more than one enterprise is relatively new. This becomes clear when looking for literature on the topic. While some models and theories are showing up, no clear articles on for example 'what to choose' are yet available.

The models and theories that are available, are often too theoretical to be used by managers of an enterprise. They don't offer a solid basis to work with, and are thus not applicable to real-life situations.

This study focuses on creating a clear, structured view on interorganizational enterprise architecture. It contributes to a clearer terminology to be used in the field, by introducing a model on interorganizational architecture types. This model also gives insight in the different possible types of architecture, and the benefits and drawbacks of them. The research also offers guidelines and principles to be used by managers who are looking into the subject.

The relevance of the specific case study is further outlined in section 1.3.

1.3 Case Study

Brandweer Hollands Midden is one of the regional fire service organizations in The Netherlands. It has to work together with a lot of different parties. Similar ones, like other fire service organizations, but also different kinds, like healthcare-oriented organizations or the emergency call center.

Certain aspects of enterprise architecture are already being used by Brandweer Hollands Midden. Managers are now looking into possibilities on extending this across organizations they collaborate with. There are still a lot of questions about interorganizational enterprise architecture though. These are questions like 'what kind of collaboration should we focus on, with similar partners or diverse ones', 'what should be the scope of the architecture' and 'what should we put into such an architecture'.

The case study conducted as part of this thesis research tries to answer part of those questions, but primarily focuses on the second subquestion as mentioned in 1.1.

The study is split up in three different parts, and results in an advice for the (information) management of Brandweer Hollands Midden on the possibilities of how to apply interorganizational EA. The three parts of the study are:

1. **Analyze the current situation within the organization.** This was done by conducting interviews with different stakeholders, and analyzing documentation about the organization and the collaboration with partners.
2. **Analyze the problems in the current situation and present possible solutions.** This was again done by talking to relevant stakeholders and asking them about what the ideal situation would look like. The model on interorganizational architecture was used to illustrate different possible situations. Every option is discussed separately.
3. **Present an advice.** The results from the research done as the first part of this thesis combined with the analysis of the case can be used to formulate an advice on whether, and if so in what way, to construct an interorganizational architecture.

1.4 Theoretical Background

To form a basis for the remaining of this thesis, some related theory and models on enterprise architecture will be discussed briefly. Some of these concepts will be projected on or adapted to interorganizational architecture in chapter 2.

1.4.1 Enterprise architecture

Enterprise architecture is used within a lot of organizations to get an overview of the organization. EA focuses on the coherence of the business processes, the supporting applications along with data, and the underlying IT infrastructure. Exact definitions are very diverse though. For example, Lankhorst et al. [13] put it as:

> A coherent whole of principles, methods and models that are used in the design and realisations of an enterprise's organisational structure, business processes, information systems, and infrastructure.

This would mean that enterprise architecture is more than just a big poster with processes and applications depicted. Ross and Weill [21] look at enterprise architecture in a slightly more detailed way:

> The enterprise architecture is the organizing logic for business processes and IT infrastructure, reflecting the integration and standardization requirements of the company's operating model. The enterprise architecture provides a long-term view of a company's processes, systems, and technologies so that individual projects can build capabilities - not just fulfill immediate needs.

The operating model is defined as “the necessary level of business process integration and standardization for delivering goods and services to customers”.

Another definition often used is the one by TOGAF [24].

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

Combining these three definitions results in an idea about what enterprise architecture is. This can be summarized as: an integrated overview of the (relationships between) business processes, information flows and the supporting applications, and the infrastructure used to facilitate this. Often there’s also a link with the environment.

Architectures often include different models, depicting the aspects mentioned above. Additionally, an architecture can also include principles and agreements that are used during the evolution of the enterprise. Data or message standards could also be part of these agreements.

A core picture of an architecture often consists of several layers, each with their own area of focus. While different architecture frameworks introduce different layers, there is one framework that gives a simple basis for building an architecture, the Dynamic Architecture framework by Sogeti, DYA.

DYA’s architecture framework states that there are three interconnected architectures within the whole enterprise architecture. These are the business architecture, the information architecture, and the technical architecture. The business architecture focuses on products and services delivered to stakeholders, the internal processes, and the organization thereof. The information architecture is about data and applications. The technical architecture gives an overview of the IT infrastructure used (e.g. middleware, platforms or servers and networks). The three layers are of course interconnected, which results in a one-piece model of the organization. As figure 1.4 shows, each layer can be subdivided into principles, directives and models, resulting in different levels of abstraction.

The set of architectures can be described for several reasons, discussed in the next section.

1.4.2 Drivers for EA

Why would an organization look into the use of enterprise architecture? The drivers for EA are as diverse as the definitions of EA. In this section, the most common ones are briefly explained.

Business-IT alignment

The alignment of the business with the IT within a company is a driver that is very important. Only looking from a business perspective is old-fashioned, because using IT to improve the business could result in great benefits.

The strategic alignment model by Henderson and Venkatraman [10] shows the different possible perspectives to look from at a business. The two axes depicted in figure 1.5 show that there should be

	Business objectives							
	Business architecture			Information architecture		Technical architecture		
	Prod / service	Process	Organ-ization	Data	Application	Middle-ware	Platform	Network
General principles								
Policy directives								
Models								

Figure 1.4: The DYA Architecture Framework

strategic fit between internal and external arrangements, and functional integration between the business strategy and operations and the IT strategy and operations. Using this model, one can start from one of the perspectives, and derive the other ones subsequently. It would for example be an option to take the ICT strategy as a starting point, and derive the business strategy and operations from that. Which starting point to choose depends on the kind of organization and the strategy envisioned by the management. Enterprise architecture could then help implementing the business and IT strategy, thus aligning these two.

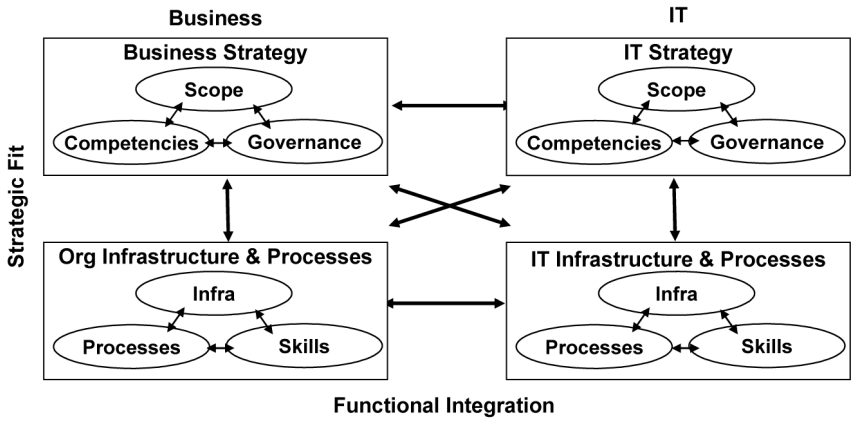

Figure 1.5: Strategic Alignment Model

EA as a management instrument

Figure 1.6 shows EA in the context of managing the enterprise. This model by Lankhorst et al. [13] shows that EA is placed between the operations layer of an organization and the layers containing the strategy and the goals. This means that EA can be used as an instrument to create a link between the strategy of a company, and the executing parties. It creates an holistic view of the company that acts as a guideline to hold on to during projects and innovations. Having an overall picture of the organization helps fitting in new parts and detecting those that will not fit. Enterprise architecture could therefore also be seen as a strategic means of communication [11].

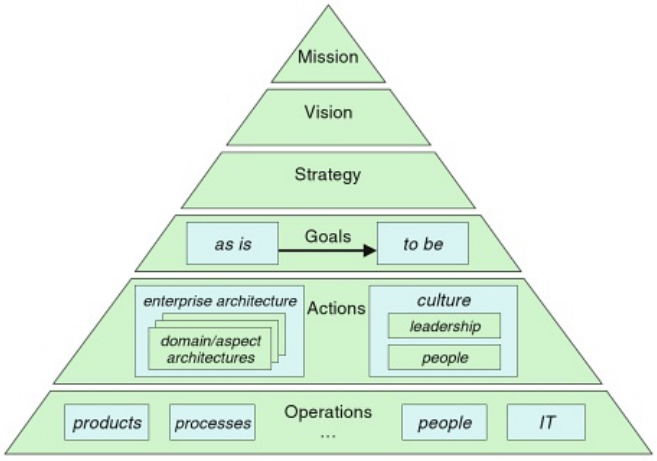

Figure 1.6: The placement of EA

Other internal drivers

Next to the abovementioned two internal drivers (which are mentioned in a lot of articles about EA) there are other internal drivers that motivate organizations to use enterprise architecture [23]. Cost reduction is one of these drivers. By creating an enterprise architecture, organizations get more insight in their own operations and IT. This can help save money by for example reducing duplicate systems or applications, and by improving work processes. Linked to this is the driver of standardization and consolidation. By using the same language throughout an organization, business processes could be made more efficient and effective and this could also result in savings.

External drivers

Not only internal drivers can motivate managers to create an enterprise architecture. External forces may also push organizations towards this approach. Acts like the Clinger-Cohen Act and the Sarbanes-Oxley Act drive organizations towards the use of enterprise architecture. The Clinger-Cohen Act for example holds CIO's of the Federal government in the USA responsible for building and maintaining an information technical architecture [5].

1.4.3 Types of operating models

In section 1.4.1 a definition of an operating model has been given. It focuses on business process integration and standardization. Four types of operating models have been defined by Ross et al. [21]. Figure 1.7 gives an overview.

When there is a low amount of business process integration, and not much process standardization either, the operating model can be labeled as diversification. This type of operating model isn't necessarily worse than the other three, because the independence of business units for example can be a very important part of the business strategy.

High process standardization combined with low integration results in the replication operating model. This model includes independent business units but makes them act in a similar way because of the standardization. Having a standard infrastructure or applications could support the efficiency within a company.

Having highly integrated business processes without much standardization leads to a coordination operat-

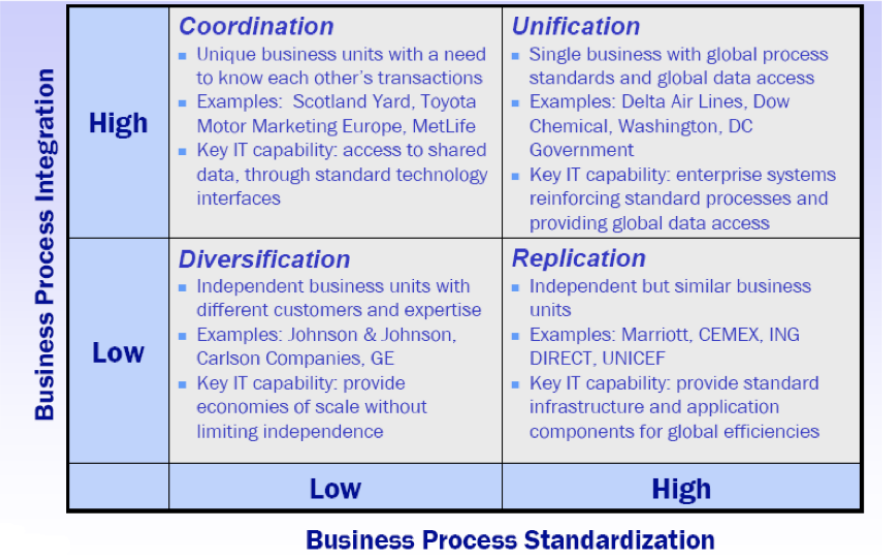

Figure 1.7: Types of Operating Models

ing model. This means that business units are unique, but they can share data because of the integrated business processes.

When both integration and standardization of business processes is high, the unification model is applied. Business units act as one business and all use enterprise systems through standardized processes.

An operating model is the driver for the business strategy. It gives a vision on how a company will enable and execute a strategy. Choosing the wrong operating model for your business could have serious consequences. Shifting from one operating model to another is possible, but may disrupt the organization. The architecture used should also be based on the chosen operating model.

1.4.4 Architecture maturity model

Figure 1.8 shows the different maturity levels of enterprise architecture [20]. Organizations start with different business silos, all completely separated. Business unit managers have full control. The next level in the model is labeled as standardized technology. In this stage, local units give up some of the control they have over their technology by adapting to the standard set by a higher board. Stage three, the optimized core, includes core business processes and sometimes also applications used. The final stage increases the local flexibility a little again, because the optimized core gives room for for example specific business modules by fitting them into the core.

The graphs in figure 1.8 show that the local flexibility drastically decreases over time, but increases again once an organization reaches the stage of business modularity. Global flexibility grows over the subsequent stages. Global flexibility is useful in adapting to the changing market as an organization, instead of as separate business units.

Going from business silos to business modularity takes time, and it wouldn't be wise for organizations to try to skip stages.

1.4.5 ATHENA Interoperability Framework

The ATHENA integrated project (Advanced Technologies for Interoperability of Heterogeneous Enterprise Networks and their Applications) is a by the European Union funded program aiming to enable

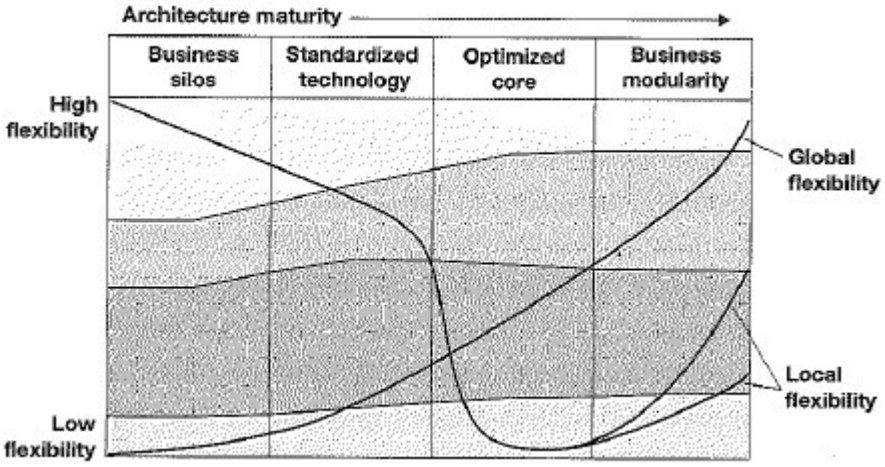

Figure 1.8: Architecture Maturity Model

interoperability by providing reference architectures, methods and infrastructure parts [22]. The project was put into a more practical form as the ATHENA Interoperability Framework (AIF) [2]. This framework focuses on interoperability between organizations from an holistic perspective. It combines enterprise modeling with architectures and platforms and adds an ontology to identify interoperability semantics in the enterprise.

The framework consists of three parts: conceptual integration, applicative integration and technical integration. The conceptual integration focuses on concepts, metamodels, languages and model relationships. The AIF describes a conceptual framework that consists of several layers or types of interoperability. This model is depicted in figure 1.9.

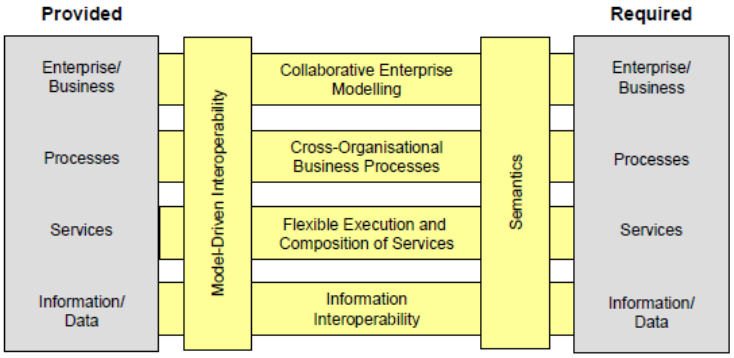

Figure 1.9: The conceptual model of the AIF

The applicative integration is more about methodologies, standards and domain models. It tries to help in solving interoperability issues by providing guidelines, principles and patterns.

Technical integration focuses on the development of technical interoperability and the ICT environments. It gives a set of tools and platforms that can be used when developing and using enterprise applications or software systems.

The framework can be used when solving interoperability issues or when orientating on the possibilities of cooperating.

Chapter 2

Interorganizational architectures

While enterprise architecture is often used within one organization, it is also possible to extend the architecture throughout more than one enterprise. This is referred to as interorganizational architecture. In this chapter the focus will be on this type of architecture. A model on different types of interorganizational architectures will be presented. Section 2.1 will describe different ways in which organizations can work together. Section 2.2 will present the model that describes different types of interorganizational architecture. The last section of this chapter, 2.4, focuses on how models used for traditional enterprise architecture can also be fit into the situation of architecture connecting multiple businesses.

The content of this chapter is primarily based on literature research and supported by data from the interviews, as described in section 1.1. The literature research is used for the theoretical background in interorganizational collaboration. The interview data is particularly used in the introduction of the model on interorganizational architecture.

2.1 Interorganizational collaboration

For various reasons organizations are joining their strengths and are working together. Whether they work together on the basis of a contract for a short period of time or they have created a joint venture, they have a common goal. There are a lot of different definitions of collaboration, most of which see it as a process of stakeholders acting with respect to a problem domain or issue [27].

While the word *interorganizational* would indicate that it is all about multiple organizations, most theories on the topic of collaboration and interorganizational architectures could also apply to the situation within one single organization, but across multiple business units (BUs). That is why in the remaining of this thesis, the word *interorganizational* will also refer to the situation of separate business units.

2.1.1 Drivers for collaboration

There are several reasons why organizations or business units would or wouldn't want to work together. An overview is given in this section. Oliver [17] defines interorganizational relationships (IOR) as 'relatively enduring transactions, flows, and linkages that occur among or between an organization and one or more organizations in its environment'. She introduced six determinants of IORs: necessity, asymmetry, reciprocity, efficiency, stability and legitimacy. These contingencies can explain the reasons why organizations enter into relationships. Galaskiewicz talks about three arenas of IORs: resource procurement and allocation, political advocacy and organizational legitimation [6]. Resource dependence is also mentioned by Pfeffer [19]. If you can get your resources somewhere else, and you don't need to produce them yourself, you'll save time and money. Improving efficiency is also a common driver according to [26].

Gray [7] describes three situations in which collaborative problem solving is a good choice. The first one is the presence of a problem that is bigger than a single organization can solve. The second one is

when there are limitations of traditional methods to resolve conflicts. In case of increasing environmental turbulence it is also a good idea to collaborate.

There also exist some important inhibitors for collaboration. The first is the fear of losing autonomy or power. When introducing a plan for collaboration, this might have influence on the freedom the concerned organizations have. When organizations might lose their autonomy, they are reluctant to entering this new way of working. Having an authoritative organization that controls the collaboration might strengthen this reluctance against forced collaboration. Another important problems comes up when targets are set too high. Collaboration should have clear and reachable goals. If these are absent, motivation for this collaboration might be less.

The drivers and inhibitors mentioned in this section are important to keep in mind when discussing interorganizational architecture. Having different drivers might cause managers to make different decisions on this topic.

2.1.2 Types of collaboration

The difference in collaboration between multiple organizations and collaboration between multiple BUs has already been pointed out. There are other ways though to make a distinction in types of collaboration.

Austin introduced the collaboration continuum (CC) model [1] for collaborations between non-profits and corporations. In this model, he makes a distinction between three types of collaboration: philanthropic, transactional and integrative. These types could also be seen as stages, implicating that it is possible to move from one type to another. The philanthropic type is about charity, simply giving and receiving. When the focus is more on specific activities like e.g. marketing, the transactional type is at hand. The final type, or stage, is the integrated collaboration. Organizations and people begin to merge, and it could result in a joint venture. Important is that one stage is not necessarily better than the other; every type suits a certain situation.

Another type of collaboration is the value chain collaboration. In this situation, several organizations work together to create a product or deliver a service that consists of several parts, delivered by the different organizations. Value chain collaboration is a kind of collaboration that won't be in the scope of this thesis, because it focuses on a single process that is executed sequentially (a linear chain) instead of like a network that is constantly connected. Chain partners often don't have the same goal. Every link in the chain gets an input, and its goal is to convert this to a certain output. The overall goal of the chain plays a less important role. One could even argue that there is no real collaboration between value chain partners, because it is often one-way traffic. In a network organization, the different parties have the same common goal, and collaborate to make it easier to reach that goal.

2.1.3 Value creation through collaboration

Value created by collaborating may differ, and may be of several types. Austin [1] introduced three groups of value that can be linked to the types of the collaboration continuum discussed before. Generic resource transfer is about simply transferring goods between partners. This is quite common in a lot of (value chain) collaborations. While this first one is normally about standard resources, the second type consists of distinctive capabilities by one or many of the collaborating parties. This is called core competencies exchange. When organizations create joint products or provide joint services, they reached the stage of joint value creation. This is normally happening in joint ventures, the third stage of the collaboration continuum.

The results of value creation can come in different types. The collaboration between two organizations could for example result in a more efficient business process, or a higher quality product. Every separate

result can be fitted into such a result category. Collaboration may also result in a joint effort that influences the results of the single organizations as well.

Hardy et al. [9] conducted a research that showed the relation between different types of collaboration and the effects of collaboration. They make a distinction between involvement and embeddedness, as two different types of collaboration. Three categories of effects were defined: strategic, knowledge creation and influence effects. Their research showed that collaborations focusing on both involvement and embeddedness resulted in knowledge creation effects. Strategic effects were strongly related to collaborations only focusing on involvement, and political effects (influence) are more likely to occur in situations of embedded collaboration.

2.1.4 Collaboration supported by architecture

Enterprise architecture can help organizations achieve benefits like improved business-IT alignment, reduced complexity and resource optimization [25]. Another claimed benefit of EA is improved integration and interoperability. The interoperability mentioned here is for example interoperability between information systems within an organization. The business-IT alignment refers to the process of fitting business processes with the IT systems within a company. EA can thus be seen as a way to design an organization. It is not unthinkable to widen the scope of such an architecture, and design a bigger organization, a group of collaborating organizations or business units. By extending (part of) the architecture across organizations, insight could be gained on how to improve the interorganizational information management, and how to better align processes and IT systems or applications. In the next section this type of architecture is further outlined.

2.2 Interorganizational architectures

To clarify what is meant exactly by the concept of interorganizational architectures, a definition is given.

> An interorganizational architecture is a (partial) enterprise architecture that focuses on more than one business or independent business unit.

Partial enterprise architectures means that some interorganizational architectures could focus on a specific layer of an enterprise architecture (e.g. business or application), or could only include general principles that normally are just a part of an EA. The reason for including business units in the definition is that enterprise architecture is also often used in a separate business unit. Creating a cross-business unit architecture would then also be an interorganizational architecture, as discussed before.

The word *enterprise* in this thesis thus refers to a single organization or business unit, as opposed to the definition by TOGAF stating that an enterprise often will span multiple organizations [24].

2.2.1 Exploring the terminology

Now that this definition is given, it is possible to look at what could be included in this definition. Literature on the topic mentions a lot of different types of architecture.

TOGAF uses the term segment architecture for ‘a detailed, formal description of areas within an enterprise [...]’ [24]. These ‘areas’ could also be business units, making a segment architecture a type of interorganizational architecture. Other terms like sector architecture and domain architecture can also be found in recent literature. They all refer to a part of an organization, or a certain market, for example the banking domain, or the education sector. No standard definitions can be found though.

Another more often used name of an interorganizational architecture is reference architecture. There is though no single definition for this type. Greefhorst et al. [8] describe a reference architecture as an abstract, general structure that can be used within a lot of organizations, and that is often not directive. A document by the DoD CIO describes a reference architecture as an organizational asset with four tasks [16]. Providing a common language for the stakeholders, providing consistency of implementation of technology, supporting the validation of solutions against proven reference architectures, and encouraging adherence to common standards, specifications and patterns. The final definition given is: 'an authoritative source of information about a specific subject area that guides and constrains the instantiations of multiple architectures and solutions'. Only from these two definitions it already becomes clear that a reference architecture can be anything between a general guideline anyone may follow, or a prescriptive document telling organizations how to organize their business. Either way, it focuses on more than one organization, and can therefore be seen as an interorganizational architecture.

The term 'chain architecture' refers to an architecture that focuses on a chain of organizations. A chain can be defined as 'an interrelated combination of separate organizations working together to achieve a shared objective, where there is forehand knowledge of the added value of each of the individual organizations' [12]. Important to notice is that there's a difference between chains that work sequentially (linear chains), and chains that don't have a standard order or flow (network chain). The sequential chains are, as previously mentioned, outside the scope of this thesis.

As shown, when looking at interorganizational architectures, there appear to be several definitions, that may also somewhat overlap. In the remaining of this section, a model consisting of different types of interorganizational architectures will be introduced, supported by theories both on collaboration as well as on traditional enterprise architecture. The terminology used in this model will be used throughout the remaining of this thesis.

2.2.2 Drivers for interorganizational architecture

Why would organizations decide to create a joined architecture? The drivers for traditional EA described in section 1.4.2 do also apply for interorganizational architecture, but in a broader sense. The drivers for collaboration discussed in section 2.1.1 are closely related to the ones discussed here.

Panetto et al. [18] mention that Enterprise Integration is about breaking down organizational barriers. The reason for doing this is to improve the synergy within the enterprise, and this would cause business goals to be achieved in a more productive and efficient way. They also point out that enterprises need to collaborate to survive in the very dynamic and heterogeneous business worlds. Chalmeta et al. [4] mention maintaining competitiveness in the dynamic world as an important driver to adopt a form of organization that focuses on getting the maximum benefits, given its resources. They also define two types of benefits that could be gained by integrating enterprises. These are strategic benefits (like a better competitive position) and tangible and quantitative benefits (like throughput times or cost-reduction).

Joining missions could also be a driver for interorganizational architecture. Interaction between enterprises that want to accomplish an overall mission by using joined capabilities could decide to introduce a shared architecture [14]. As shown in section 1.4.2, EA is a tool that supports the vision and the mission of an organization. Creating an interorganizational architecture could then support a joined vision and interorganizational missions.

2.2.3 Perspectives on interorganizational EA

When designing an interorganizational architecture it is important to think of the role it should have. Will it be prescriptive, or just act as a guideline? How much autonomy will the concerned parties still have?

Questions like these lead to different perspectives or scales on which you can position an architecture. These dilemmas (implicitly or explicitly) came up during the interviews conducted for this research.

Guiding vs. prescriptive

An architecture can include principles that are just meant as a guide organizations could follow. Another approach is defining rules that should be followed by all the organizations adopting the architecture. The same may hold for models, applications or processes included in the architecture. Both approaches may have their benefits and drawbacks, and may be suited for certain situations only.

Central authority vs. autonomy

In some situations, it may be useful to have a central authoritative party that can make decisions (possibly on more than the architecture) and makes sure that every organization complies with the set architecture. The other option would be to not have a central authority, and leave every organization autonomous. Both situations are depicted in figure 2.1.

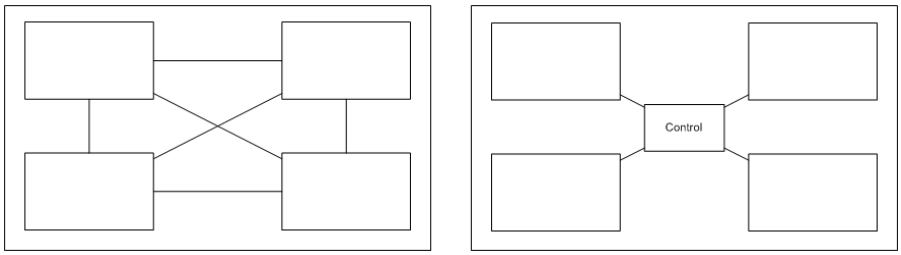

Figure 2.1: Autonomous (left) and controlled organizations (right)

Diverse vs. similar

There is a big difference between working together with organizations that work in the same business, and working together with organizations that don't. For example, educational institutes could decide to create an interorganizational architecture to improve the working process, or allowance organizations could create an architecture with employment agencies to be able to easily share information about unemployed people. The goal, content and role of an architecture may differ greatly depending on this difference.

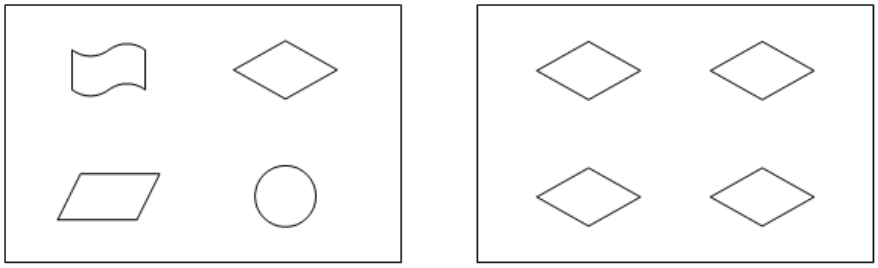

Figure 2.2: Diverse (left) and similar organizations (right)

By design vs. grown over time

Some architectures are not designed at a specific time with a specific goal, but have just grown over time. Agreements once made may have become standards that are adopted by other organizations. One doesn't always have to be necessarily better than the other, this depends on the situation.

High-level vs. specific

The envisioned results for enterprise architecture may influence the level of detail of the architecture. A high-level architecture often only includes some principles or non-prescriptive guidelines, to be applied by organizations. The opposite would be an architecture that includes detailed process models and information schema's, ready to be implemented. Note that this is something different from the authority-autonomy perspective.

2.3 Introducing a model for interorganizational architectures

Before being able to say anything about what type of architecture fits what situation best, a model is needed to identify the different types. In chapter 3 the model will be further discussed. From the perspectives described in section 2.2.3, two were chosen to be combined into a model. Combining the two perspectives results in four types of architectures.

The two perspectives chosen are:

- Central authority vs. autonomy
- Diverse vs. similar organizations

These two perspectives were selected because they represent two important questions that often rise when talking about interorganizational EA. One other perspective that is included in the model is the perspective on high-level versus specific. This will be discussed later in this section.

The different types of architecture are depicted in figure 2.3. Every type of architecture will be further discussed hereafter. This is though just a short explanation of the model. The content of every type of architecture and the benefits it could provide are further discussed in chapter 3.

Segment-based architecture The segment-based architecture focuses on dissimilar organizations, controlled by a central party. This may be the general board of a big company with different business units, or it may be a separate organization that is in control of different other organizations in a country, or across countries. An architecture of this type will often be prescriptive, just as the authority-based one.

Authority-based architecture The authority-based architecture focuses on similar organizations that are under the control of a controlling entity. This could for example refer to hospitals that are under the control of a national health institute, that laid down an architecture to be implemented by the hospitals.

Chain architecture When different parties are working together on a specific market or topic, they can work together in a so-called chain. In this situation, dissimilar organizations work together under a chain architecture, possibly supported by a central (but not authoritative) entity (the dotted box).

Sector architecture Organizations of the same kind can also work together to reach a certain goal. Organizations in the same sector can introduce a sector architecture to help reach that goal. It may again be the case that there is a central entity that manages (part of) the architecture.

Reference architecture As already discussed in section 2.2.1, there is no fixed definition of a reference architecture. It is clear though that a reference architecture focuses on multiple organizations, making it an interorganizational architecture.

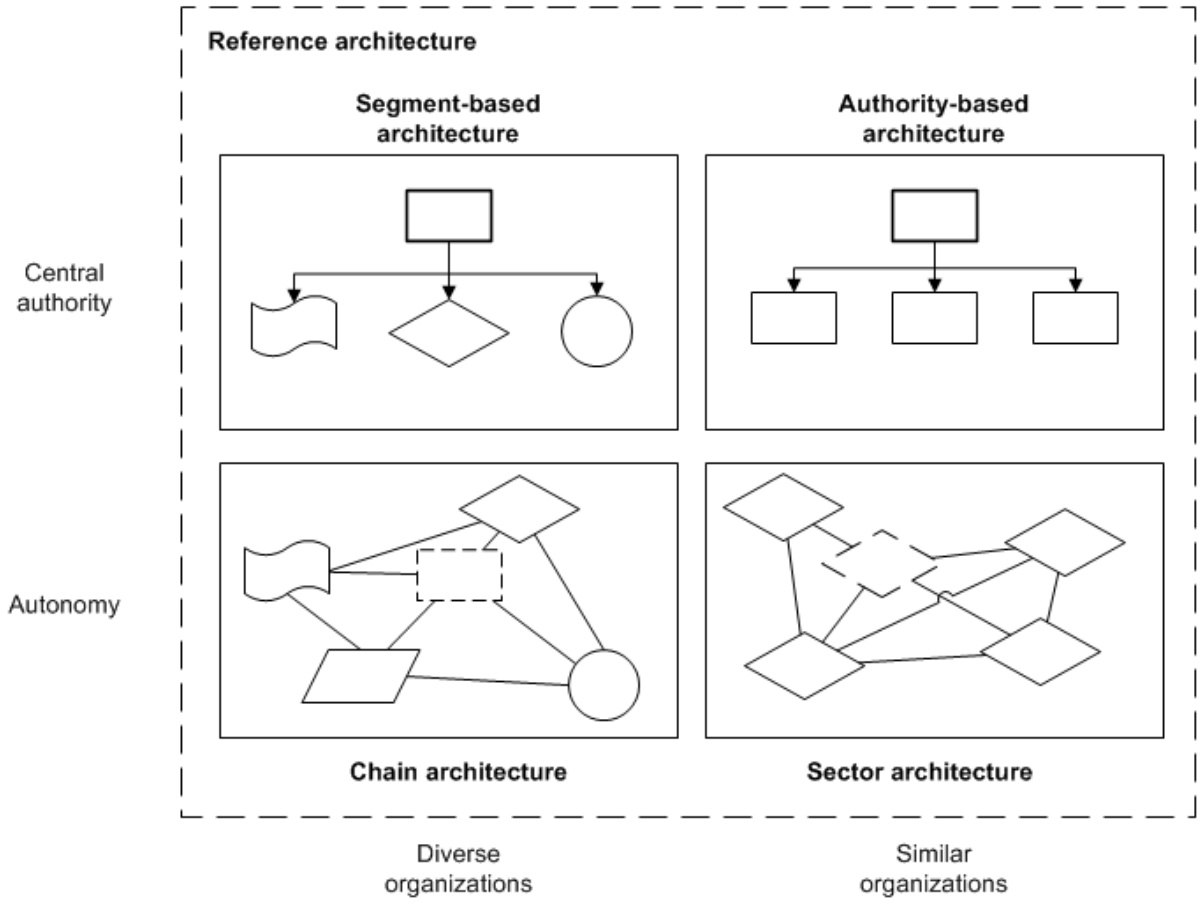

Figure 2.3: Interorganizational architecture model

Next to the two axes that form the quadrants, it is possible to think of a third axis. This axis would represent the extent to which an architecture is specific. The less specific an architecture is, the more difficult it is to place it in one of the quadrants. That is why reference architectures is placed as an overall architecture behind the quadrants. A reference architecture is often not that specific, but could shift to one of the quadrants once it is made more specific.

It should thus be clear that there could be some discussion about whether an architecture fits in one of the quadrants of the model, or whether it is more like a reference architecture. It is hard to set any specific rules for this.

In the figure the different architectures are positioned in a way that they don't overlap. This overlapping could though occur. Imagine an organization that is active in a certain sector, but is also working together with other organizations in other sectors in a chain. This might cause friction because an organization then has to comply with two architectures, which may not fit with each other.

An architecture could also move across the two main axes, or, as previously mentioned, between the 'reference-level' and one of the quadrants. This is important to realize, because most architectures won't fit all the specifications of one of the quadrants, as will become clear in chapter 3. In that chapter, each of the five architecture types will be analyzed, and the content and likely benefits and drawbacks of an architecture will be discussed.

2.4 Interorganizational EA models

Most models and theories on enterprise architecture focus on a single organization. Sometimes the idea of business units is taken into account, but collaboration between different organizations is out of scope. However, most of the concepts could be extended or adapted to fit the situation with multiple organizations. In this section, a couple of well-known models are put in context of interorganizational architecture.

2.4.1 Operating models

The different operating models described in section 1.4.3 could also be looked at from the perspective of interorganizational architecture. This situation is depicted in figure 2.4. Diversification would refer to the situation in which organizations don't work together, or at least not in a standardized or integrated way. The coordination quadrant would describe the situation of diverse organizations that need to work together, and therefore need to integrate their common or complementary processes.

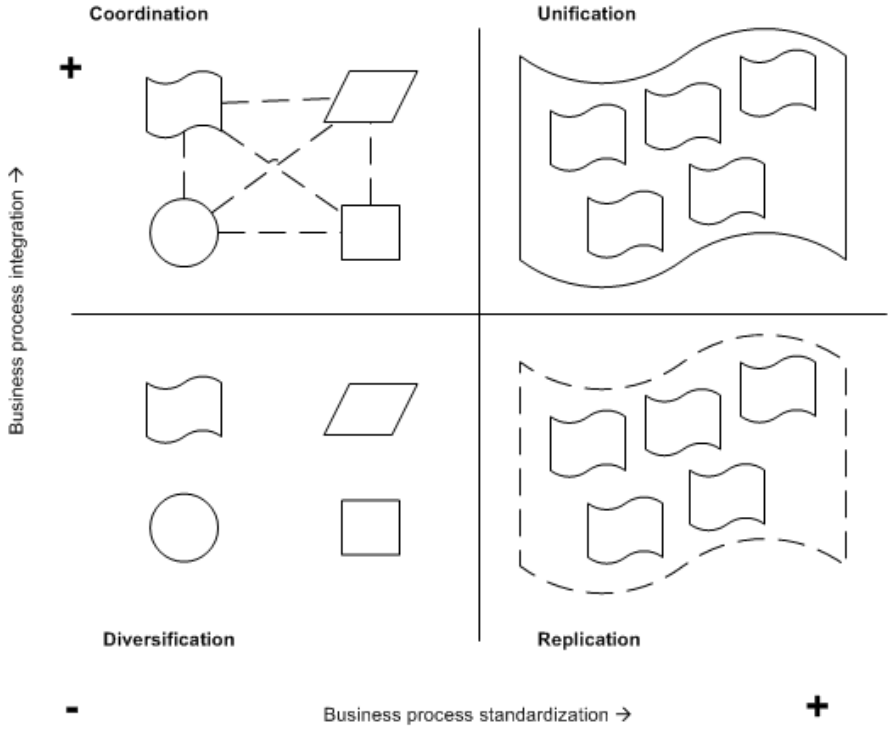

Figure 2.4: Interorganizational operating models

Replication focuses on business process standardization. This quadrant represents the independent organizations that focus on adopting e.g. a standard for data transfer. The original model states that the organizations are similar, but it would also be possible to agree on standards for diverse organizations. The final quadrant, unification, combines business process integration and standardization. In an interorganizational context this can be seen as similar organizations working in a similar way (e.g. different banks owned by the same mother organization).

Operating models can be adapted to fit an interorganizational situation. For a lot of situations though, it might not be so easy to place a situation in the model. The best way to look at this model is like it is a coordinate system with two axes. An instance of interorganizational collaboration can be placed somewhere in the system. A third axis might represent the diversity or similarity of the organizations.

This model can help visualize the possibilities of interorganizational partnerships. The type of collaboration between partners influences the type of operating model chosen. The type of operating

model for a collaboration might then again influence the choice for a certain architecture type from the interorganizational architecture model.

It is not the case that the quadrants of both models describe the same situation. A collaboration that chooses the operating model in the upper left doesn't necessarily have to use the architecture type in the upper left of the interorganizational architecture model.

2.4.2 Maturity levels

The architecture maturity model mentioned in section 1.4.4 focuses on bringing the different business silos within an organization together and create an organization that is based on business modularity. The same can go for linking separate organizations together. They start as independent organizations, with all local flexibility, but not a lot of global flexibility. Local flexibility refers to all the internal matters of an organization. Global flexibility is the ability to adapt as a group to a changing environment or market.

When organizations start working together, they can focus on getting to the next stage. In the original model this is the standardized technology stage. Interorganizational architectures often focus on standards regarding data and messages, instead of a standardized IT infrastructure. In this stage, local flexibility starts to decrease, because organizations have to comply with the set standards. Global flexibility however starts to increase. By working according to the same standards, it is easier to implement changes that require all organizations to adapt.

Not all interorganizational architectures might focus on getting to the next stage, which is the optimized core. It could be the case though that an architecture describes the main processes to be implemented by the concerned parties. Assuming the targeted organizations would actually do this, this would create an optimized core. Local flexibility is again further decreased. By standardizing the processes though, the organizations are more predictable and it is easier to change the way of working as a group.

Business modularity creates more local flexibility again. Having a standard basis to work with, organizations can fit their own specific processes or applications into this core, using the global data and applications.

It is no requirement for interorganizational architectures to end up in the business modularity stage. In most situations, the second stage will be the final stage. The third and fourth stage might overlap in practice. There will always be some specific part of the organization or business unit that is not included in the architecture, but that has to fit in it.

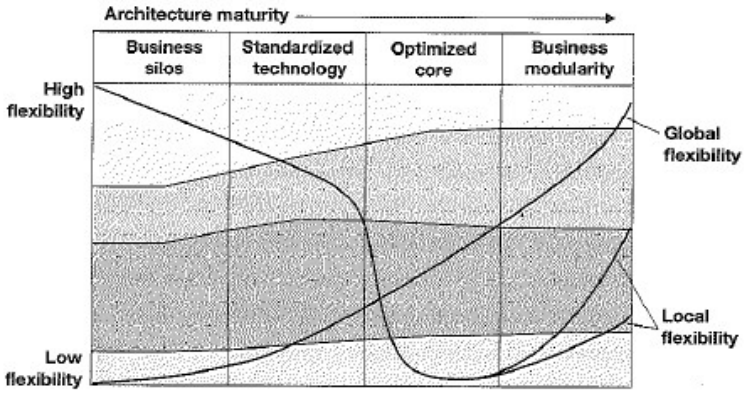

Figure 2.5: Architecture Maturity Model

Chapter 3

Analyzing the model

Now that a model on interorganizational architecture has been introduced, a further inspection of the model will be given. In this chapter, the different types of architecture of the model will be discussed one after another.

To analyze every architecture in the same way, the main concept of the ATHENA Interoperability Framework (AIF) will be used, discussed in section 1.4. For this analysis, the three parts of the AIF are used as if they are three areas on which to focus while designing an interorganizational architecture. These areas are conceptual integration, applicative integration and technical integration. By using this method, all possible components of an architecture will be discussed. An overview of the focus areas of each architecture type according to the AIF is given in figure 3.1.

For every type of architecture, two figures are added. One represents the (common) content of a certain type of architecture. This figure is based on the DYA model, discussed in section 1.4, because this model gives a clear overview of what could be included in an architecture. It is important to mention that because the model on interorganizational architecture represents a continuous space, the figures representing the content depict the most distinctive situation, not the only possible one. The row with 'policy directives'

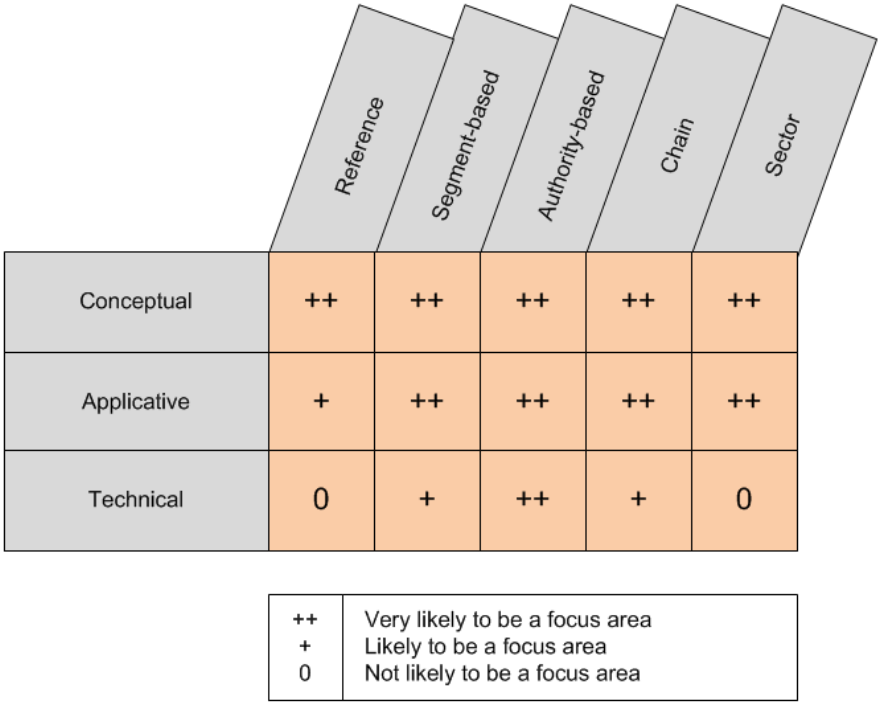

Figure 3.1: An overview of the focus areas according to the AIF levels

is considered more as 'policy regulations' to distinguish between the principles (non-prescriptive) and the prescriptive statements. The second figure gives an overview of the specific characteristics of a type of architecture. These characteristics are split up in two categories, positive (white) and negative (red) characteristics. The positive ones can also be considered as drivers to choose that type of architecture. If one is e.g. looking for a way to make the shared processes between organizations more efficient, it would probably choose for the architecture type that has 'more efficient business processes' as a result.

As outlined in section 1.1, the analysis of the model on interorganizational architecture is primarily based on interview data and documentation on specific interorganizational architectures. This data was combined into tagclouds that give an overview of which characteristics fit each type of architecture. To do this, the analyzed architectures were placed in the model. That way, each architecture was linked to a certain type, and type-specific characteristics could be identified. Some additional literature was used to further support certain aspects of the analysis.

3.1 Reference architectures

Reference architectures (RA) are often used as a guideline for multiple organizations. They are designed in a way that makes them useful for organizations in their own situation. It is often the idea that they are used as a guidance in designing a specific architecture for an organization. A reference architecture is not prescriptive, organizations can choose themselves whether or not to (partially) implement them.

The content of a reference architecture may differ a lot from one architecture to another. Some reference architectures only consist of a set of principles to follow and terminology to be used, thus focusing primarily on the conceptual integration. Other reference architectures also include standards for messaging and communication, or even reference models for a specific sector [8]. Applicative integration is also an area of focus in that case. Technical descriptions or applications that would be described as part of the technical integration are not part of a reference architecture.

The analysis showed that reference architectures often include principles and non-prescriptive guidelines. Reference descriptions, like business function models or applicative function models can also be part of the architecture. This type of architecture can focus on the three basic layers of architecture (business, information and IT infrastructure), but doesn't go very much into detail. As discussed in section 2.2, a reference architecture often has a high level of abstraction, but may move into one of the quadrants in the model when developing to something more specific. The (ideal) use of standards is often described in a reference architecture. The focus then is on communication standards like message standards and interfaces to connect applications and data sources.

Using a global architecture like an RA can have many goals. Looking at the results from different architectures and literature on reference architectures, some main results show up. Reference architectures are designed for multiple organizations or business units. Collaboration between those organizations is important, and rolling out an RA should help improve that collaboration. By creating an overall architecture, an holistic view is created that should help give more clarity to the concerned organizations. De Boer et al. [3] put it as a lack of coherence that drives organizations to the use of an RA. As with most (enterprise) architectures, benefits like cost reduction, increased efficiency and improvement of the working processes are gained by using an RA. To what extent these results are reached depends on the level of detail a reference architecture has, and the extent to which organizations fully use an architecture. Greefhorst [8] states that selecting the applicable parts of a reference architecture is part of the process of using one. While the different parts of an architecture are often linked to each other, it is questionable whether implementing only part of an architecture would benefit an organization as much as when fully using it. This might though again depend on the abstraction level of the architecture.

	Business objectives							
	Business architecture			Information architecture		Technical architecture		
	Prod / service	Process	Organ-ization	Data	Application	Middle-ware	Platform	Network
General principles	X	X	X	X	X	X	X	X
Policy directives								
Models	X	X	X	X				

Figure 3.2: Content of reference architectures

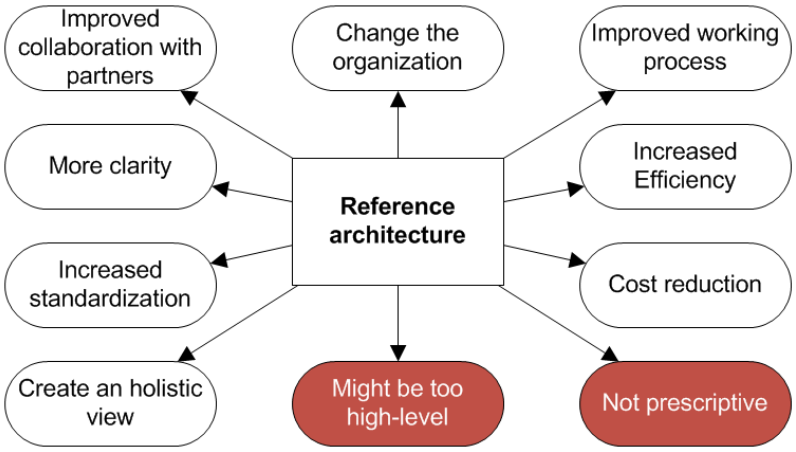

Figure 3.3: Characteristics of reference architectures

A possible pitfall of reference architectures could be that they are too high-level. On the other hand, being too specific while looking at a broad scope might also cause problems. The chance of organizations that are not willing to use the architecture because it is too specific then increases. Being non-prescriptive doesn't have to be a bad thing, but it leaves the possibility for organizations to only partly adopt an architecture (or not at all), decreasing the results aimed for. Reference architectures are therefore often used to guide the design of a more focused and specific architecture by a smaller group of organizations or a single one.

3.2 Segment-based architectures

When working together with organizations that don't work in the same sector, it could be useful to create a joined (partial) architecture. In the case of having a central authoritative entity who creates or initiates this architecture and to which all concerned organizations are accountable, a segment-based architecture (SBA) is in place. This type of architecture should be able to connect different organizations in a way that increases the integration and collaboration between them. The umbrella organization is responsible for designing and maintaining the architecture, and checking compliance with the architecture. This organization could be a government, introducing an architecture to be adopted in a specific chain of organizations, but it could also be a separate organization that is put in place to facilitate the organizations

concerned with this architecture, and support them in adopting and implementing it.

Another situation in which a segment-based architecture could be useful is in an organization that has different business units focusing on different products. This would mean that these BU's work under the same authority, but in a different way, with another focus area. An SBA could help in creating a common way of working among these different business units.

To create alignment between the different organizations an SBA should include a starting point, something every organization can use as a basis for their own processes and facilities. Including reference processes and descriptions, along with general principles can strengthen this basis. Conceptual integration and applicative integration are therefore both part of an SBA. Having standards throughout an organization with multiple BU's or multiple separate organizations can create a common language and will improve interoperability. Characteristic for this type of architecture is that there is also a technical integration part. Applications or databases that are used throughout an organization or deliver services to a set of organizations can be managed by a central organization. IT systems like servers and networks could also be part of the architecture, but this is more likely when looking at connected business units. Separate organizations often have their own IT infrastructure. One of the architectures analyzed though has a special network infrastructure put in place to transfer data between health care organizations that have adopted the architecture. This network is maintained by a central party. That organization cannot force any organization to adopt the architecture, but once they have chosen to do that, they are accountable to the central organization.

Directives regarding the business architecture are not included in this type of architecture. This is because of the diverse organizations involved. It is possible to include principles on which to base e.g. the business processes, but they are too diverse to put in a general architecture.

	Business objectives							
	Business architecture			Information architecture		Technical architecture		
	Prod / service	Process	Organ-ization	Data	Application	Middle-ware	Platform	Network
General principles	X	X	X	X	X	X	X	X
Policy directives				X	X	X	X	X
Models	X	X	X	X	X	X	X	X

Figure 3.4: Content of segment-based architectures

A segment-based architecture supports the primary processes within the group of BU's or organizations. It helps standardizing data and messages, and thus supports interoperability. Having a common starting point gives more clarity and insight into the organization. If an architecture also focuses on the technical integration, this could also have a positive effect on the application integration. Working with the same applications could lead to more effectiveness and efficiency. Organizations that work with the same applications or at least use applications that can easily share data will have less difficulties working together, and that way work in a more efficient and effective way. The benefits mentioned when discussing the reference architecture like cost reduction and creating an holistic view are also applicable to segment-

based architectures. Additionally, by moving towards a specific quadrant within the model, other results may be reached. This also holds for all the other architecture types discussed hereafter.

By having a central authority, the autonomy of the concerned organizations is limited. This could limit the flexibility on organizational level, but at the same time improves flexibility on the global level. As discussed in section 1.4.4 global flexibility gives the opportunity to adapt to the changing market as a group of organizations instead of as a single organization or even business units.

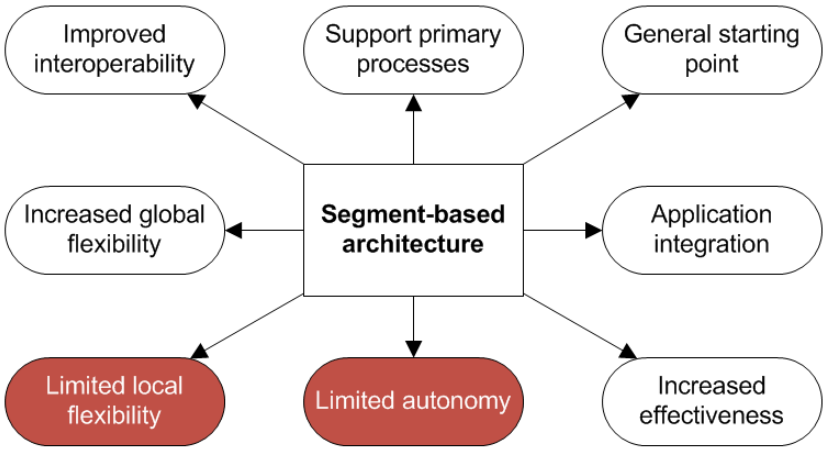

Figure 3.5: Characteristics of sector-based architectures

3.3 Authority-based architectures

An organization that is segment-based but has only similar segments (BU's or organizations) focuses even more on the authoritative function of a central party. This situation occurs for example when a big enterprise has different business units based on geographic regions, as is the case in one of the analyzed situations. Most processes are the same, and applications (and sometimes even IT infrastructures) used are also highly standardized. A little local freedom is required to be able to respond to local developments and innovate. This type of architecture is called an authority-based architecture (ABA).

Looking at the AIF, an ABA can focus on conceptual, applicative and technical integration, just like the SBA. The difference lies in the fact that because of the similarity of the concerned organizations or BU's it is possible to put down an architecture that goes much more in depth. Conceptual integration again consists of things like reference models and reference processes. These will have a prescriptive character though in this type of architecture, as discovered during the analysis. Principles or directives to be followed and standards to be used are part of the applicative integration. These standards are more likely to focus on applications as well, and may even include IT infrastructure standards. This is possible because similar organizations can often use similar applications, and using the same applications could result in certain benefits, discussed later. On the technical integration level an ABA can also go much more into detail. Having set certain IT systems like servers or workstations as a standard can benefit the integrated way of working and complying with the set standards. One of the architectures analyzed shows that putting a central server in place that has to be used by the (in that case) different BU's, improves the use of standards, saves costs (because the separate BU's don't have to buy it themselves), and enhances maintainability.

An ABA thus focuses on all three traditional architecture layers. Business processes can be set as a standard as well, but this depends on the type of partition that the BU's are based on. If these are based on geographic region, one could expect that the business processes are more likewise than in the case of a partition based on customer type (e.g. SME's or consumers). The role of the authoritative party can change

depending on the type of subdivision of the organization. Applications used by the different partners could also be standardized. This is again cost-effective and improves the compliancy with standards [15]. Sharing data between similar applications is also easier than between dissimilar software suites. There is no need though to fully define a software suite. It would be fine if certain business units decide to use for example open source software for their office environment, as long as it is still possible to comply with the standards and principles set out in the architecture.

	Business objectives							
	Business architecture			Information architecture		Technical architecture		
	Prod / service	Process	Organ-ization	Data	Application	Middle-ware	Platform	Network
General principles	X	X	X	X	X	X	X	X
Policy directives	X	X	X	X	X	X	X	X
Models	X	X	X	X	X	X	X	X

Figure 3.6: Content of authority-based architectures

All types of interorganizational architecture can be seen as providing an architectural basis for the concerned parties. An ABA will probably do this most far-reaching. This also contributes to the results achieved by implementing an architecture like this. The benefits mentioned in sections 3.1 and 3.2 are also applicable to the authority-based architecture. Additionally, an ABA contributes to a larger extent to the integrated service delivery of the organization. Imagine that by using the same architectural basis the different business units work together better and the service delivered to the customer is improved. If business processes are established in the architecture and every BU works according to these descriptions, the image shown to the outside world (customers or other stakeholders) will also be more universal.

As discussed in section 1.4, legislation can also be a driver for enterprise architecture. A lot of organizations have to comply with certain regulations. This could be national regulations, but also e.g. European laws often influence the way organizations organize their business. International companies may even have more difficulties because in different countries different regulations are applicable. Architecture can help making sure all organizations automatically comply with the regulations if they comply with the architecture. While architecture can support compliancy with the rules, this can also introduce a new problem. The broader the scope of the architecture, the more rules that have to be dealt with. This can make the architecture and its implementation more complicated. In case there are changes made in the legislation, an interorganizational architecture can help in quickly adapting to the new situation. On the other hand, as discussed later, it takes time to implement changes in an ABA at all concerned organizations.

Going in-depth with an interorganizational architecture brings out another challenge. It is hard to innovate. If one of the parties that implements the architecture wants to introduce an innovative product, service or application, it needs to fit within the architecture. If it appears to be successful, it could be decided to include these innovations in the architecture. Innovating for a group of organizations or BU's is harder though than it is for a single organization. The former takes more time than the latter, and the administrative process is more demanding. It can take years before an innovative idea is implemented throughout the organizations.

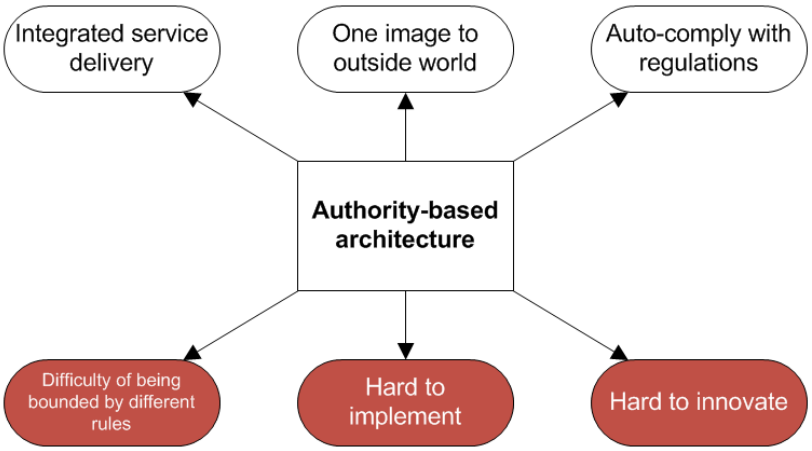

Figure 3.7: Characteristics of authority-based architectures

By having an authoritative entity that controls the implementation of the architecture, envisaged results are more likely to be reached. But, as made clear in this section, there are some negative effects of this type of architecture as well. It is possible to use a downsized version of an ABA, but the results may then be less as well.

3.4 Chain architectures

Diverse organizations often work together because they have the same goal or they can use each other to meet their own targets. The same again can happen in case of different business units within one organization. When the level of autonomy of the diverse organizations is high, the architecture used is called a chain architecture (CA).

Chain architectures focus on retaining the autonomy of the different partners. There is no central authority in place that has control over the linked organizations. A managing party that takes care of shared components or developing and maintaining the architecture is an option though. A chain architecture is often not imposed, and partners are free to join. Once they decide to adopt the architecture, it may be the case though that they have to implement all parts of the architecture. Adopting only a part of the architecture is often not possible, and not useful either.

One of the main drivers for introducing a chain architecture is information integration between diverse organizations, sharing of data between the different partners. This may have an underlying driver like integrated processes or other kinds of collaboration.

Conceptual and applicative integration are very important in chain architectures. Bringing diverse organizations closer together asks for understanding each other, using the same language, and possibly even working in the same way. Technical integration can also be part of a chain architecture, but it is not necessary. Especially because of the diversity of the partners this might be less feasible. It is not excluded though, as became clear from one of the analyzed chain architectures. In that specific case, a service bus was put in place to connect all the different data sources from the various partners. This service bus was managed by the central party.

Chain architectures can focus on all three basic architecture layers. Reference processes and descriptions often stay high-level. The idea of a chain architecture is often to stay out of the internal matters of the connected organizations, and focus on the interfaces that make interoperability easier. Defining standards for messages and data transfer is therefore very important. Sharing data should be made as simple as

possible. The required availability of data should also be taken into account when designing a chain architecture.

	Business objectives							
	Business architecture			Information architecture		Technical architecture		
	Prod / service	Process	Organ-ization	Data	Application	Middle-ware	Platform	Network
General principles	X	X	X	X	X	X	X	X
Policy directives				X	X			
Models	X	X	X	X	X	X	X	X

Figure 3.8: Content of chain architectures

To support the integration and sharing of data a chain architecture could include guidelines for the applications of the partners, as one of the analyzed architectures did. An organization that would like to adopt the architecture must adapt its applications to comply with the architecture standards. This might have a serious impact on the internal working process, and raise the hurdle to implement the architecture. A less radical solution could be to include a set of message standards that is expected to be used by the applications. How this is done is up to the organizations themselves. It might still ask for modifications made to the applications, but this kind of updates often requires less time and thus money.

Both chain architectures analyzed for this research include a central data transferring unit put in place. One acts like a service bus and connects different registrations of partners directly. The other architecture puts out guidelines for the applications of the partners, and has a central library that can be used to request the availability and location of certain data. The actual fetching of the data doesn't go through this central hub. Additionally, a private network, completely separated from the Internet, offers the possibility to share data in a secure way. This is required because of various privacy issues in the sector.

Complementary service delivery can be supported by a chain architecture. By creating an architectural link between diverse organizations in a certain sector, information can be available to all parties when needed. This makes it easier to provide services to customers, and complement each others services.

One of the main difficulties with working in a chain architecture is the governance part. By not having an authoritative entity, the question might be raised who is responsible for central facilities and for developing and maintaining the architecture. In the analyzed architectures there was a managing party that took care of that. In other situations it might be the case that representatives of all concerned parties form a group together to fulfill this task.

Apart from the specific characteristics depicted in figure 3.9, most of the positive results of a segment-based architecture (the white boxes in figure 3.5) and the benefits of a reference architecture (figure 3.3) are also applicable. Because of the autonomy within a chain architecture the application integration is often less, but is replaced by information integration. That could be seen as a higher-level type of integration.

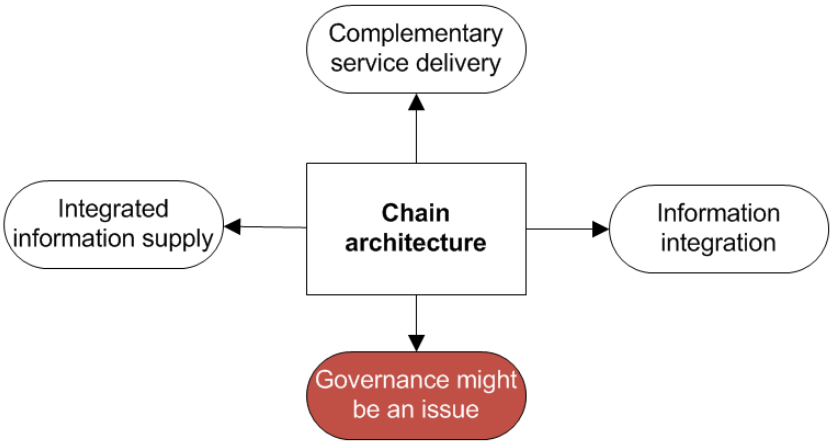

Figure 3.9: Characteristics of chain architectures

3.5 Sector architectures

The last type of architecture in the model is the sector architecture (SA). This architecture focuses on similar organizations that retain their autonomy. Banks could for example be linked by using a sector architecture.

The level of conceptual integration in such an architecture can be quite high. Reference models and descriptions to be used by the separate organizations can be included in this architecture. The level of detail can be higher than e.g. in a chain architecture, because of the similar type of organizations. Applicative integration is often very important in an SA. Introducing standards and methodologies is easier to do when applicable to similar organizations, and they can be more specific. Technical integration could also be a focus while designing an SA. Especially for organizations in the same sector it could be useful to introduce shared applications or pre-defined IT systems. This is always a difficult part of an architecture though, and not having an authoritative organization could make this even harder to introduce and maintain. That is why it is almost never part of a sector architecture.

The analyzed architecture only focuses on the business layer and the application layer. As just mentioned, it would also be possible for an SA to focus on the IT layer, but this depends on the goals to be reached. A sector architecture could be seen as a form of a reference architecture for a specific sector. The big difference though is the level of abstraction and the extent to which it is agreed to impose the architecture.

Because the concerned organizations of a sector architecture are similar, it is possible to include specific reference models that are to be used. This supports the internal model-making process of the organizations. A possible drawback of a specific sector architecture is the interference with the internal enterprise architecture of an organization (see also figure 3.11). This could also be the case with a chain architecture, but it is more likely that a chain architecture will focus on the interfaces between diverse organizations instead of the internal matters of an organization. This could happen in a sector architecture though, and is therefore something to watch for.

The positive characteristics of the authority-based architecture and the reference architecture could also be linked to sector architectures. The difficulty to innovate might also hold for sector architectures, but by having autonomous organizations it would be easier to innovate at least locally.

Now that all types of architecture in the model are described, it is important to mention that it is possible to have an architecture that contains aspects or delivers benefits of both a sector-based architecture and

	Business objectives							
	Business architecture			Information architecture		Technical architecture		
	Prod / service	Process	Organ-ization	Data	Application	Middle-ware	Platform	Network
General principles	X	X	X	X	X	X	X	X
Policy directives	X	X	X	X	X	X		
Models	X	X	X	X	X	X	X	X

Figure 3.10: Content of sector architectures

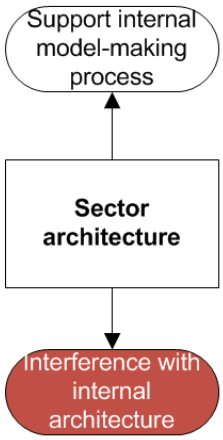

Figure 3.11: Characteristics of sector architectures

an authority-based architecture, or other combinations. Every architecture can be placed somewhere in the model, giving insight in the main drivers and results of an architecture. As previously mentioned, an architecture might also shift from one position in the model to another because of developments within the architecture. The positive characteristics of a reference architecture may hold for every other type of interorganizational architecture.

Chapter 4

Case Study: Brandweer Hollands Midden

Enterprise architecture is being used in all sorts of organizations. Also (semi-)governmental organizations are putting effort into developing an enterprise architecture that supports decision-making and gives an overview of the organization.

Brandweer Hollands Midden (BHM), one of the fire service organizations in the Netherlands, is also using EA to get more insight in the different parts of the organization and how they fit together. Because BHM cooperates with a lot of different partners, within and outside of their network organization in the region (the safety region, or 'Veiligheidsregio' in Dutch), they are also looking into the use of interorganizational architecture. There are a lot of questions concerning this topic, which will be discussed in this case study.

The case will be presented in a couple of parts. First, an introduction on Brandweer Hollands Midden will be given. The current situation will be discussed, focusing on EA and related issues. The section thereafter discusses the Veiligheidsregio Hollands Midden (or VRHM), the network organization of which BHM is a part. The current situation and problems regarding collaborations and interorganizational issues will be outlined next. After shortly discussing VERA, a reference architecture focusing on safety regions, some developments in the sector will be introduced. An analysis of the options based on the model on interorganizational architecture will be presented thereafter. Combining these parts will result in an advice on how to use interorganizational architecture in the case of Brandweer Hollands Midden.

As already discussed in section 1.1, the information used to write this chapter was gathered from organizational documents and interviews with people from the concerned organizations. Those include people from BHM and the other disciplines of the VRHM, but also people from other regions and national organizations like Brandweer Nederland, the national fire service organization.

4.1 Current situation

In this section the organizations included in this case study will be introduced and the current way of collaboration is described.

4.1.1 Brandweer Hollands Midden

In the Netherlands there are 25 regional fire service organizations. Brandweer Hollands Midden includes 47 fire houses in 25 municipalities. It has 1400 employees divided into five sectors. These sectors are:

- Corporate staff
- Risk management

- Operational preparation
- Incident control
- Resources

The tasks of BHM can be summarized as the ‘safety chain’. This chain includes the following five tasks:

- Proaction (prevent risky situations from occurring, e.g. advise on construction plans)
- Prevention (improve safety, e.g. prevent fires from happening, decrease chance of accidents in case of a fire)
- Preparation (including preparing personnel and resources, training, practice, emergency plans)
- Repression (the actual assistance)
- Aftercare (prepare for the next call, getting back to the ‘normal’ situation)

These tasks can be linked to the three main activities within BHM, which also all have their dedicated department within the organization. Looking at the different primary and supporting activities, the following indicative value chain can be created.

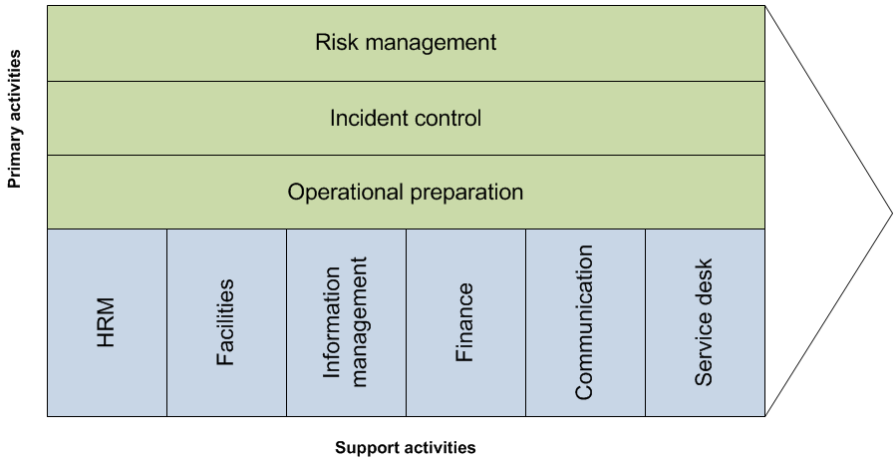

Figure 4.1: The value chain of Brandweer Hollands Midden

Risk management
The department of risk management focuses on the proaction and prevention tasks. The department is split up in three teams. Advisory, object preparation and surveillance. Advisory has to do with all sorts of permits. When building a new mall, for example, the fire department checks the building plans. In case of a big event, BHM also advises on how to cope with a big crowd. Object preparation has the task of preparing the fire department for an incident at a certain location. They make maps of buildings, advise on road blocks and update the system with geo-information. Surveillance checks whether advices given by advisory are followed, and is present to oversee events.

Operational preparation
Operational preparation is split up in planning, competence, and the knowledge center. Planning is responsible for describing plans, procedures and guidelines. Competence has the task of educating and

training the employees, and make them practice their skills. The knowledge center gathers, stores and enriches information available in the organization, to be used in future situations.

Incident control
Most visible for the community is the incident control department. Their responsibility is acting in case of a fire, an accident, or any other situation in which assistance from the fire department is requested. The department has employees available to guarantee a fire service for the region 24x7.

Supporting activities The supporting activities depicted in the value chain are part of the organizational sectors 'corporate staff' and 'resources'. These activities are organization-wide and support the three primary activities. Information management is the department responsible for the information systems within the organization and process optimization. This is also the department that is primarily engaged with the enterprise architecture.

Enterprise Architecture (IST)

Figure 4.2 shows an enterprise architecture core diagram of BHM. The activities in the value chain can be put into the top layer of the architecture as processes. The middle layer includes the most important services needed by the processes, and the applications that provide these services. The bottom layer represents the main IT infrastructure components that facilitate the applications. The idea behind a core diagram is to create an overview of the coherency between the main parts of the organization. Details are therefore often left out of the diagram.

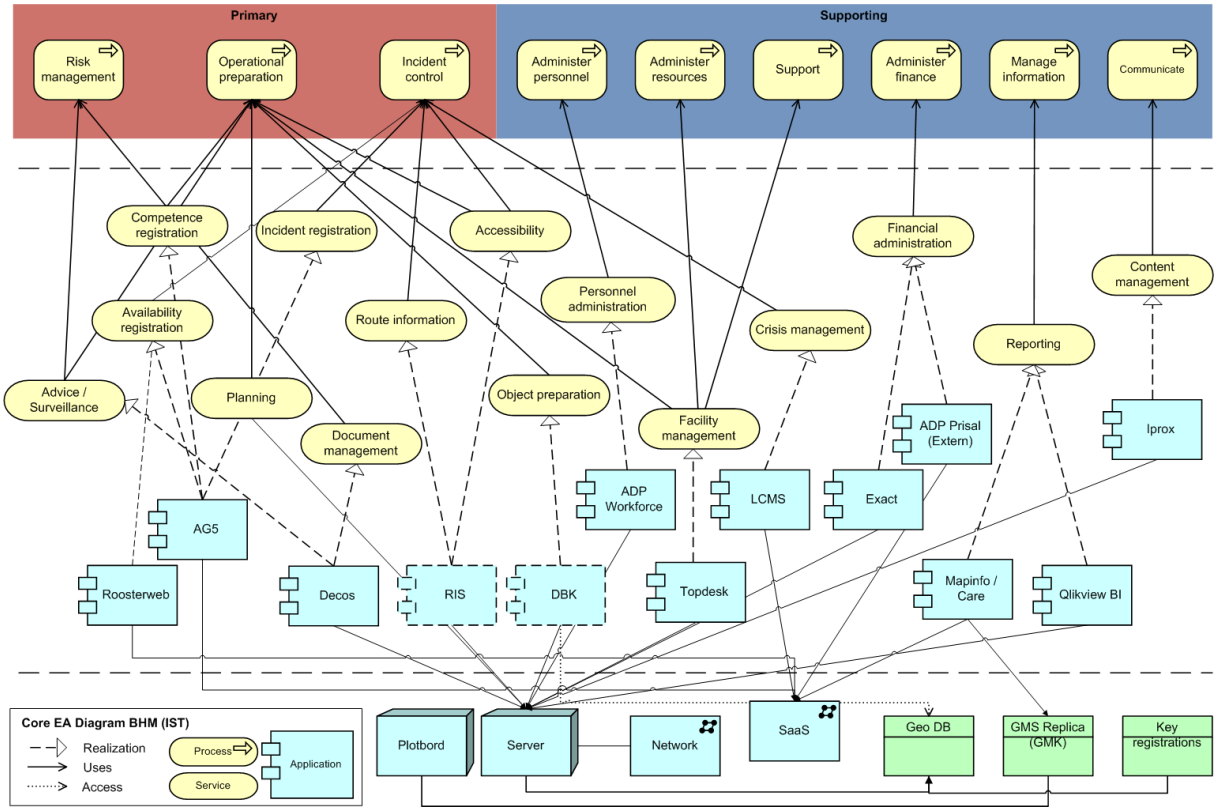

Figure 4.2: The IST core diagram of BHM

IT infrastructure
BHM has an in-house IT infrastructure. The ICT department controls and maintains this environment. All workstations of BHM and the BGC (another discipline within the safety region, discussed later) are

connected to a network. Servers provide storage space and run the applications that are installed on them. Some applications run in the environment of the provider, as a SaaS solution (Software as a Service).

The servers contain a lot of data used by the applications. Soon, a database containing geo-information will be put in place. This database is linked to key registers from the Dutch government with information on buildings and topographic information. There is also a link with a replica server of GMS, the software used by the emergency call center (GMK). The 'plotbord' box represents the system that shows the availability of the different units in the region. This system is used at several places, for example in different fire stations. It uses the information from the GMS replica.

Services and applications
The risk management process uses two important services. Advice and surveillance is supported by a standard application like Outlook, in order to be able to share documents with external organizations. The document management system (Decos) is used to organize cases and share document within the department.

Operational preparation also uses the advice and surveillance service to consult given advices. Competence registration (registered in the SaaS application AG5) is used to see who can do what, and register training and practices. The planning service is used to create plans on buildings or other objects. These plans are saved directly on the server. The DBK application (Digitale Bereikbaarheidskaart) offers the possibility to add information about buildings and objects on for example emergency exits, key safes or gas pipe valves. This is called object preparation. The accessibility service offered by RIS (Route Informatie Systeem) is used to gather and save information about the accessibility of objects.

Also the availability registration (schedules etc.) is used by incident control, just like route information and accessibility. Incident registration is a service realized by AG5. It allows commanding officers of the fire department to register which fire fighters were at the scene, or who came to the firehouse. For bigger incidents, the higher commanders can write a report on an incident. For this reason, AG5 is linked to the GMS replica server. Every incident is automatically imported in the application after it is closed by the GMK. When a bigger incident takes place, requesting coordination of multiple disciplines, a crisis management system called LCMS (Landelijk Crisismanagement Systeem) is used. This application is owned by the IFV (Instituut Fysieke Veiligheid), the Dutch institute on physical safety. It can be used to combine information of the different disciplines and create an integrated view of an incident.

The supporting processes are supported by dedicated applications. Personnel administration is realized by ADP Workforce. Facility management by Topdesk, which is used by both the administration of resources as well as by the support process (service desk). Exact combined with ADP Prisal realize the service of financial administration. For business intelligence purposes there are two applications. Qlikview can be used to build reports to support the information management process. Related to that, Mapinfo (with the Care extension) and Hyperion focus on geo analysis. For content management, Iprox is used. It is used to communicate to employees of BHM.

The core diagram, as well as the given description, does not include every application used within BHM. It shows the most important ones, and the connections with the directly related processes. That way it will be easier to see the impact of proposed changes in a later stage.

Enterprise Architecture (SOLL)

To improve efficiency within the organization and create a general guideline for future projects, the information management department introduced an 'integrated information system landscape', a visionary overview of the coherence of information systems within BHM. It is depicted in figure 4.3. The model is split up into three layers: operational, administrative, and generic. Operational includes the functionalities

that are closely related to the primary activities of BHM. Administrative focuses on the organizational registrations, branch-specific and general ones. Generic functions are functions that can be used in a broad sense and may be used by other organizations than BHM.

This EA document primarily focuses on the separate organization of BHM. Some parts are designed considering the possibility of linking it with other partners though, for example those present in the safety region.

An important part of the architecture is the information hub. It contains the planning administration, the geo-information registration and the BI database. This part has a connection with the actor called 'partners within the safety region', and thus focuses on the connection with other organizations. Several registrations are linked to the geo registration, making it a central registration with an important role.

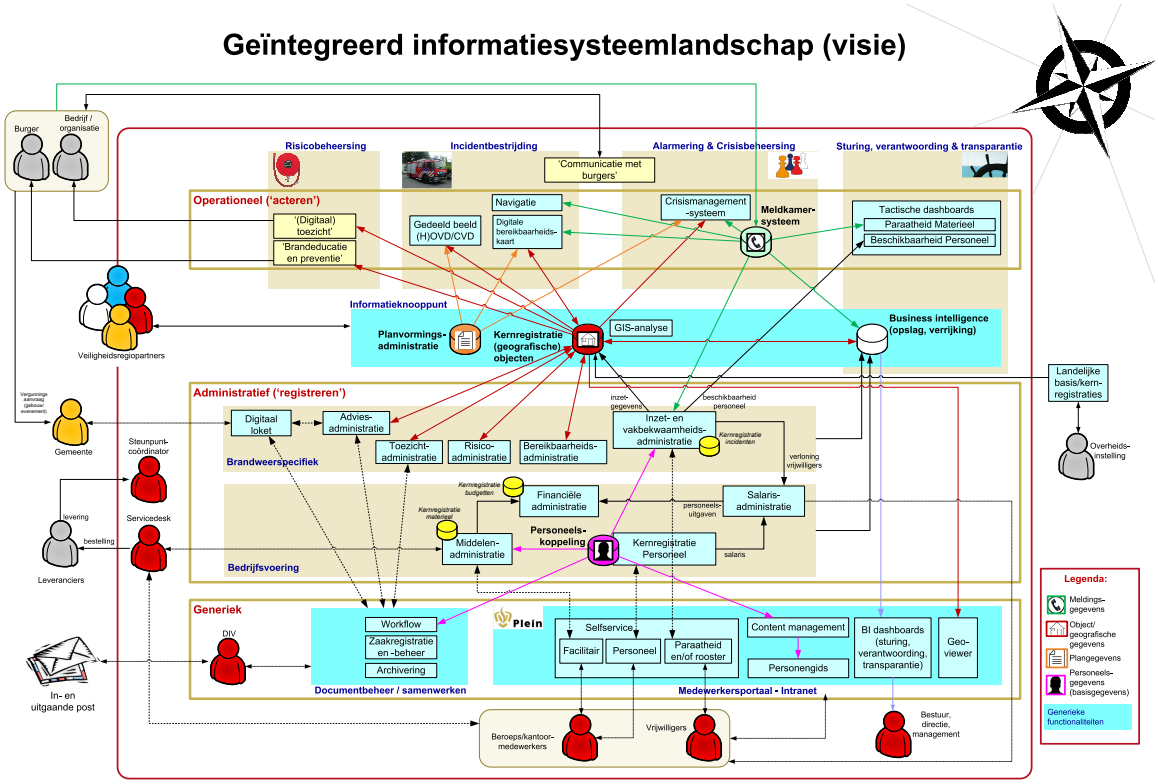

Figure 4.3: The information system landscape of BHM

4.1.2 Veiligheidsregio Hollands Midden

The Netherlands is split up into 25 safety regions. This is regulated by a Dutch law called 'Wet Veiligheidsregio's', introduced in 2010. According to this regulation, a safety region has the following tasks:

- Take stock of the risks of fires, disasters and crises
- Advise the competent authorities on the risks of fires, disasters and crises in certain situations
- Advise the executive board of the municipalities on their tasks regarding fire services
- Prepare for the fighting of fires and organize the emergency response and crisis management

- Organizing and maintaining a fire service
- Organizing and maintaining an emergency health service (GHOR)
- Offering a dispatch functionality
- Buying and organizing common equipment
- Organizing and maintaining the information of the different partners within and outside the safety region

Veiligheidsregio Hollands Midden (VRHM) is one of the safety regions in the West of The Netherlands (number 16 in figure 4.4). Cities like Leiden and Gouda are among the 25 municipalities located in this area.

Figure 4.4: The Dutch safety regions

In the VRHM the police, fire services (BHM), medical services (GHOR), dispatch (GMK) and municipalities (BGC) work together on guarding the safety in the region. Additionally, they work together with several partners like the water board and utility companies. The safety region is managed by an executive board and a governing board, supported by several teams.

The tasks of the VRHM are split up in:

- Risk management
- Planning
- Training & Practice

- Incident control
- Information management
- Communication

The several disciplines working on these tasks (just as BHM) will be discussed in the following sections.

Geneeskundige Hulpverleningsorganisatie in de Regio (GHOR)

The GHOR coordinates, directs, and advises on the medical assistance in emergencies and crisis management. On a daily basis, a lot of different organizations provide medical assistance to people. In case of a disaster, there is a need for a coordinating actor, which is the GHOR.

Together with 'GGD Hollands Midden' (GGD-HM, the public health service) and the 'Regionale Ambulance Dienst Hollands Midden' (RAD-HM, ambulance care) the GHOR-HM is part of the 'Regionale Dienst Openbare Gezondsheidszorg Hollands Midden', or RDOG-HM. Both the GHOR-HM and the GGD-HM are part of a national organization. These two national organizations are acting as one since January 1st 2014, called 'Publieke Gezondheid en Veiligheid Nederland', PGVN. An overview is given in figure 4.5.

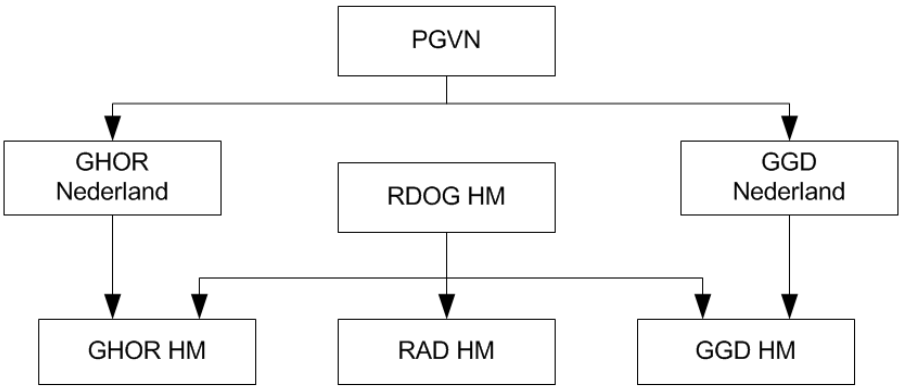

Figure 4.5: Connections GGD / RAD / GHOR

Gemeenschappelijke Meldkamer (GMK)

The emergency call center and dispatch, the GMK, is the central organization that receives emergency calls, sends the call to the right emergency service, and acts as a lifeline for the responders.

The GMK is part of the police organization, but is manned by people from different disciplines. Most of them are employed by the GMK, except for some people who have an advisory task or who also fulfill another role at one of the disciplines.

Bureau Gemeentelijke Crisisbeheersing (BGC)

This organization supports the municipalities in the VRHM on crisis management and emergencies. The law on safety regions prescribes having a coordinating officer who is responsible for the coordination of the measures taken and the facilities offered by municipalities in view of a disaster or crisis. The BGC also coordinates the picket functions of the municipalities, for example the people who coordinate evacuation in case of an emergency.

Police

Since January 1st 2013 the Dutch police act as one national organization. The goal is to work more efficient and effective. The organization consists of ten units that together cover the whole country. The VRHM works together with the unit The Hague, that covers the area of the VRHM and the VRH (Veiligheidsregio Haaglanden, number 15 in figure 4.4). The police are an important partner of the VRHM.

4.2 Collaboration

Brandweer Hollands Midden works as a separate organization within the VRHM. As made clear in section 4.1.1, the organization has all generic departments like finance and personnel set up for itself. In the case of the GHOR, these tasks are executed by the RDOG.

When discussing the cooperation within the VRHM a distinction can be made between 'warm' situations (when acting on an incident) and 'cold' situations (when not acting on an incident). It is important to keep this distinction in mind, but at the same time see that there is a link between these two. Working as separate partners in cold situations might result in a more difficult environment to cooperate in a warm situation. To indicate whether a task, process or application refers to one discipline or covers multiple disciplines, the terms 'mono' and 'multi' will be used. In this section, 'mono' will refer to BHM.

Multi departments
Within BHM there are two departments that have a multi-scope. The people working there are employed at BHM, but their work focuses on the various disciplines within and around the VRHM. One of those departments focuses on planning. They make multidisciplinary plans and procedures, and write disaster management plans. The mono department focuses only on the fire department. The other multi department manages the multi education, training and practice. They make sure there are enough multi-exercises, and that multi-employees are educated and trained adequately. Again there is also the mono department that does the same for the fire department.

Multi workgroups
Apart from these multidisciplinary departments there are a couple of workgroups that act as advisory bodies. They consist of representatives of the different disciplines, and have a certain topic of focus. They do not decide on or control multidisciplinary issues, but advise the related departments or boards. Examples of those groups are MDI (information management), MDOTO (education, training and practice), and MDOP (operational planning).

4.2.1 BHM - GHOR

The cooperation between BHM and the GHOR is limited. Both parties have their own generic systems like personnel administration and finance. They most often act as separate entities. In the cold situation, cooperation doesn't include much more than sharing documents. When advising on e.g. a big event, the GHOR as well as BHM give their input, and documents are shared to be combined and adapted to each other. During an incident, both disciplines cooperate when necessary, by following their normal working procedures. The multi departments of BHM also focus on the GHOR as one of the disciplines.

There are no shared processes between BHM and the GHOR, although they have overlapping tasks. From analyzing business and application function models it becomes clear that there are several business functions that are executed by both BHM and the GHOR, apart from the ones that are discipline-specific.

- **Education, training and practice** - Although the specific exercises and knowledge of fire service

employees and employees of the GHOR are different, the process of registering skills is the same, as is the application that is used. Both parties have no knowledge of each other's employees' skills though.

- **Operational information management and coordination** - During an incident information has to be shared, and there has to be some form of coordination. Working according to other standards or methods may make it more difficult to communicate.

- **Advisory on risk management and events** - As previously mentioned, advice on events or building plans can have a multidisciplinary character. At the moment though, these are handled as a mono advice, and combined afterwards. Knowledge about what the other discipline is advising is absent during the process.

- **Planning** - Both disciplines are making their own plans on risk management or incident control. A lot of that information is meant for a specific discipline. Building plans and information on specific objects could be useful for multiple disciplines though. Apart from the plans made by the multi department, this information is not available for all partners.

When looking at applications used, there is also some overlap. AG5 is used to register the competences, but both disciplines have their own part of the application. Document management is supported by Decos, but again the applications are not connected, making it harder to share documents. The national application LCMS is used by different partners in case of a big incident. The local (VRHM) part of the application is managed by BHM.

4.2.2 BHM - GMK

The GMK is managed by the police. They are responsible for the working process and administrative tasks. As previously mentioned, people with different fields of expertise work in the call center. Obviously, the GMK cooperates with all the different disciplines in case of an incident. The information available on incidents is shared with BHM via a replica server of GMS, the main application of the GMK. Via this server, information is made available to applications of BHM like AG5 or the business intelligence suite. This situation is depicted in figure 4.6. A service level agreement (SLA) defines what can be expected of both parties with regard to the cooperation.

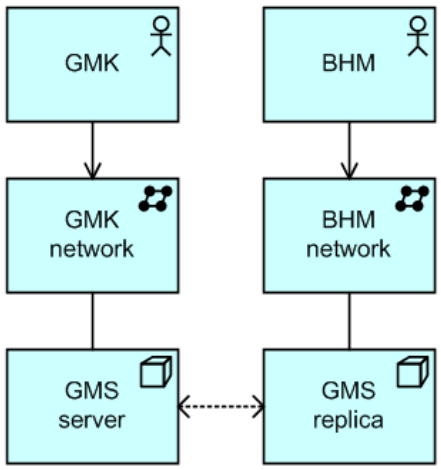

Figure 4.6: The replica server of the GMS system

4.2.3 BHM - BGC

The BGC joins some working groups in which BHM also takes place. In those situations, knowledge and experience are shared. Documents are shared via email when necessary. BHM and the BGC don't share any applications, although they work on the same network. The questions is raised though whether or not the BGC should use AG5 to register the competences of the various picket officers.

4.2.4 BHM - Police

Like the BGC, the police take place in working groups when they have a multi-focus. They are an important partner of the safety region, and therefore cooperation is necessary. A problem in sharing information with the police is that this could be privacy-sensitive information, and therefore cannot be shared, or can only be shared in case of an incident. This makes it harder to use the information for preparation and could hinder the related processes. It could also result in a partial or even faulty preparation, due to the absence of certain data.

4.3 Cooperation outside of VRHM

Brandweer Hollands Midden is also cooperating with partners outside of the VRHM. Meant by this are other safety regions or national organizations. In this section the current collaborations will be discussed and any problems or hitches are pointed out.

4.3.1 Surrounding regions

There are six regions that border on the VRHM. In case of an incident, they work together if necessary. In cold situations, this cooperation is very limited. Some regions communicate about their way of working, and share some documents via email. Any form of structured collaboration or information integration is absent in most regions. There are several reasons for that.

Since the introduction of the 'Wet Veiligheidsregio's' in 2010, the different regions have started to regionalize their different disciplines. The fire departments for example were part of the municipality at first, but that changed to being a part of the safety region. On January 1st 2014, the second last region finished the regionalization. One region still has to go through that process. Between the already regionalized regions there are still a lot of differences. Some regions still work as if they are separate disciplines, others have a common part that acts as 'safety region', and a smaller discipline-specific part. These differences make it harder to cooperate, because the way of doing things may often not fit with other regions.

Another problem is the managerial complexity. Setting up a cooperation between regions asks for clear agreements, and support by concerned managers and employees. If these are absent, initiatives will probably fail.

Most regions give regional developments a higher priority than interregional ones. This is justifiable, but an impediment for collaboration and information integration. On top of that, every region chooses to do most things for its own. This is because of the 'Not invented here' syndrome, and because every region sees itself as unique. For some part, this might indeed be the case, but generic functions like document management might very well be similar.

For safety regions there are also some specific drivers that could move managers to start cooperating with other regions. In certain high-risk areas like those around airports, or near the North Sea, it could be wise to share information on certain objects or prepare disaster plans together. It is also often the case that a

certain region has some expertise knowledge on a certain topic, for example railway accidents or heath fires. It is important to have that kind of information widely available, and not to keep it for yourself.

4.3.2 Environmental service

Within the region the Omgevingsdienst Midden-Holland (ODMH) works on creating and maintaining a safe, sustainable and healthy environment. Its main tasks are licensing, surveillance and enforcement of environmental legislation, building inspection and advising, developing and implementation of sustainability policies. The ODMH is part of the national organization ODNL (Omgevingsdienst Nederland).

BHM and the ODMH often work together when advising on developments within the region. They agreed on a covenant that states what can be expected from both parties. Because collaboration between these two parties is often at hand, architecture is also a subject of conversation. Because the ODMH is an organization outside of the VRHM and not directly part of the safety sector, the collaboration will not be discussed in detail. It will be taken into account in the advice given later on in this thesis.

4.3.3 Brandweer Nederland

All 25 safety regions in the Netherlands include a fire service organization. These organizations all work in their own way, according to their own processes and plans. Just as it is between the safety regions, documents are shared via email and organizations watch each other on certain projects or share ideas. Little is done in the form of a cooperation. The same reasons described in the previous section hold for this situation, focused on the fire service discipline. Even though one could argue that fire services are even more equal than complete safety regions, autonomy and uniqueness are highly valued.

Brandweer Nederland is the national organization that facilitates the various fire service organizations in the regions. It has three main tasks:

- Interest representation of the 25 regional fire services
- Information management
- Development and offering of products and services to the Dutch fire department

The organization has no authority over the regional services, they are all autonomous. This has to do with the fact that regions want to decide on their money spending and working processes by themselves. Because of this, all regions use their own set of applications, and design their own processes. Information integration doesn't reach a high level.

4.3.4 National

The presidents of the safety regions together form a national organization called Veiligheidsberaad. This organization puts effort in creating a decisive organization for disaster management and incident control. It is the leading management on the development of the safety regions. It also acts as the connecting organization between the government and the safety regions, and manages the Instituut Fysieke Veiligheid (IFV).

4.4 General barriers

In the previous sections, while discussing the current situation regarding collaboration some problems were mentioned that could oppose collaboration. There are also some general issues that arise in every related situation and don't support collaboration within the sector.

4.4.1 Every organization for itself

Within the VRHM, every discipline acts as a separated organization, and wants to stay that way. While in other safety regions this is different, the VRHM is just a small umbrella organization, consisting of several strong organizations like BHM and the GHOR. This can be explained by looking at the way the VRHM originated: by putting together a couple of diverse organizations. The VRHM chose to keep them as separate organizations. While this is a justifiable choice, it could cause problems when looking at ways to collaborate within or outside the safety region. One important reason why acting as separate organizations would be better is the 'brand' that people are used to. Everyone knows the fire department, the ambulance and the police. Far less people know the safety region. Acting as separate organizations could therefore smoothen and benefit your working processes.

4.4.2 Difference mono and multi

Linked to the previous paragraph is the problem between mono and multi developments. It happens that decisions are made from a mono perspective, while this actually has an impact on the multi-level. Looking in the other direction, multi-decisions could influence processes or systems in the mono organizations. The vision on this dichotomy mono vs. multi plays an important role in the decision-making process.

4.4.3 Linking information systems

Having different organizations with different information systems causes information to be spread across these systems. This doesn't mean the information isn't related, and often requests are made for combined information that should be gathered from multiple systems. Not all information systems are linked though, which makes it harder to fulfill those requests. The information is available, the question is how to make it available in an integrated way.

4.4.4 Uniqueness

Every organization says to be unique. This also holds for the organizations within the safety sector. This idea impedes the way to collaboration, and even more hinders any form of standardization. If everyone thinks they are different, it's a long road to agreeing on a standard. For collaborating the same problem holds, because at least one of the concerned parties will have to adapt to the other one.

4.4.5 Governance complexity

Making a decision in one organization can be very hard. Making a decision that concerns multiple organizations may be even harder. Choosing to cooperate on certain projects or invest in an information system together becomes less likely. Instead of one management board that needs to agree on something it is required for multiple boards to agree on the plan. Partly because of the seeming uniqueness of every organization the process of reaching an agreement can take very long.

4.5 Envisaged results

Now that the current situation on collaboration is discussed, together with the problems that are present at the moment, the high-level goals can be described. In the discussion about the problems during the current collaboration and the general barriers, some implicit goals already became clear. Two main things that BHM is looking for are better cooperation with partners, and saving costs.

Better cooperation is often reached by improving interoperability and information integration and by aligning processes. BHM is looking at the safety region as well as to the fire department discipline. Both are different environments, but with likewise issues. There are different ways to come to these results, as already showed in this thesis. Two important areas of focus in this case should be:

- Data standardization (within the VRHM and fire service organization, but also with other organizations)
- Process standardization (primarily within the fire service sector)

These two areas would also contribute to the second main goal: cost reduction. Saving costs may sometimes conflict with other goals, and implementing projects that will improve cooperation may cost extra money at first, but will deliver cost reductions after successful implementation. Cost reductions are often realized by solving other underlying problems that cost a lot of money. Therefore the focus should be on those problems, like e.g. working inefficient or ineffective, or having redundant IT systems.

4.6 VeRA

In 2012 a reference architecture for safety regions was introduced, called VeRA (Veiligheidsregio Referentie Architectuur). This architecture focuses on creating an integral information management for the administrative organization, the cold preparation of emergency care, and the upscaled crisis management within a safety region. This should benefit the cooperation and information sharing between partners within a region, and between regions.

VeRA 1.0 is based on the NORA (Nederlandse Overheid Referentie Architectuur), the reference architecture of the Dutch government. NORA contains principles, models and standards for the design of an electronic government. A lot of other reference architectures like GEMMA (municipalities), MARIJ (government) and PETRA (provinces) are also based on the NORA. The NORA uses a framework to depict the areas of focus of the architecture. This framework is shown in figure 4.7. VeRA focuses on two of the nine sectors of the framework, as depicted in figure 4.8. The architecture focuses on the who-question in the business and information architecture layer.

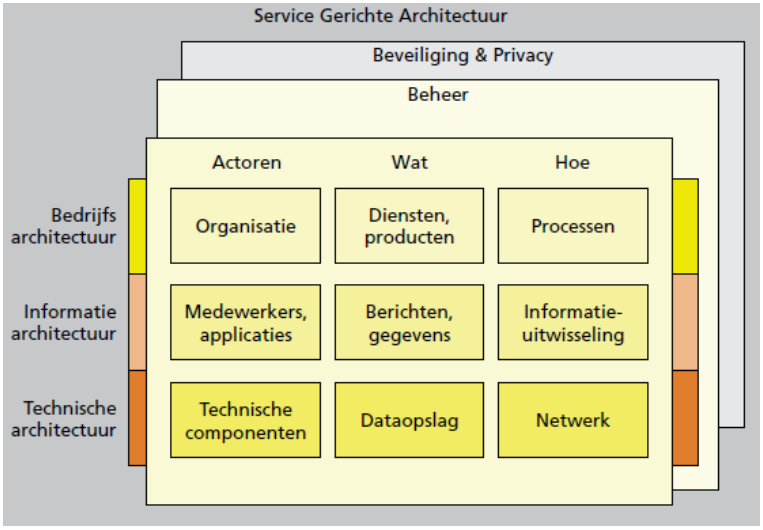

Figure 4.7: The NORA framework

There are three main parts in the architecture: a vision and principles, a business function model and the application function model. The vision and principles describe the ideal situation that is supported by the architecture, and guidelines on how to get to that situation. The business function model gives an overview of what a safety region does, divided in five domains. The application function model is an addition to this model, adding applicative functions to the several business functions. One of the domains described is the data-domain. In this domain different registrations are placed that are used within a safety region.

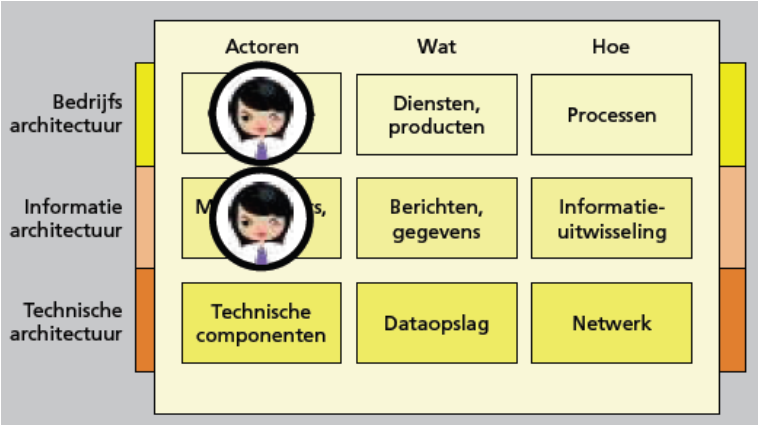

Figure 4.8: VeRA placed on the NORA framework

The VeRA architecture has been enacted by the Veiligheidsberaad (formed by the chairmen of the 25 regions) in September 2012. The architecture is not very specific, and leaves a lot of room for interpretation and implementation.

At the moment of writing this thesis, a second version of VeRA is being written. This version focuses on the upper six parts of the NORA framework, and is slightly more detailed. It is not yet finished though, and will therefore not be discussed in detail.

4.7 Developments

The pace of change is very high in the world of information management. In one or two years the whole basis of an information system landscape may get changed. It is therefore important to look at current developments before presenting an advice. The developments described in this section can have a serious impact on the way the different disciplines and different regions work together. Of these developments, an overview of the current status and plans will be given. These developments will be kept in mind when forming an advice.

4.7.1 National Police

Since January 1st of 2013, the regional police forces and the KLPD (national force) form one national police organization. It consists of 10 regional units, each supervised by a police chief, a national unit, and a supporting service unit for the operational management tasks. A force chief is in charge of the national police. The minister of safety and justice is politically responsible.

The national unit of the police is responsible for interregional and specialized police work. It supports the regional units with its resources when necessary. The regional unit BHM will have to cooperate with is Haaglanden. It was formed by combining the former regional forces Haaglanden and Hollands-Midden.

Benefits of forming one national organization can be found in the centralization of generic tasks like ICT, personnel and procurement. There is less bureaucracy, and the different parts of the police organization can cooperate faster and better. Officers have less paperwork to do, which results in more time available on the streets.

It is important to keep the developments around the police organization in mind, because they are often part of the safety region. Because the safety regions and police regions are no longer the same, it is

important to realize that one police unit now has to cooperate with (in the case unit Haaglanden) two different safety regions.

4.7.2 Nationaal Meldkamersysteem (NMS)

The software system used by the emergency call center / dispatch (GMK) is outdated. It was developed halfway the 90's, and although it is constantly updated to fit in the current situation, time has come to replace it. In 2010 it was decided to replace GMS (the current system) by a standard of the market suite. In 2012 a project focusing on the preparation of the public tender started, which should be finished by the end of 2013.

Another development linked to this is the formation of a national emergency call center organization (Landelijke Meldkamer Organisatie, LMO). The idea is to decrease the amount of call centers to 10, instead of the current 22, and put them as one organization under the authority of the minister of safety and justice. In the end, they have to act as one national virtual emergency call center. That means that every center would have to be able to take over another center in the country at any moment. The National Police would be responsible for the LMO, but the LMO would be in charge of the centers.

The formation of the LMO and the introduction of NMS have a huge impact on how the cooperation between the different disciplines and the LMO in every region will have to be organized. At the moment, every call center has its own way of working, adapted to the working processes and naming conventions of its region (e.g. unit numbers and messages). When introducing a national virtual organization, it would for example have to be possible for a call center in the north of the country to alarm a fire department in the south. This can be achieved in two ways:

- NMS supports the naming conventions and working processes of all different regions
- All regions use the same (concerned) ways of working and agree on a naming convention

Part of the LMO project is the creation of a set of standard working processes. That means LMO focuses on standardization, and aims at standard ways of working for all centers. Safety regions will have to adapt to these standards, and make sure they can cooperate with every emergency center.

4.7.3 Merging of safety regions

Although no real plans are known at the moment, it might be a future development to merge safety regions, and have as much regions as there are police units. Looking at the national police (with 10 units) and the formation of the LMO (with 10 emergency call centers), it would not be unthinkable to decrease the amount of safety regions. Of course, this would also have its impact on the way cooperation would be arranged. Having bigger safety regions could make the decision-making process harder, because of a bigger organization. On the other hand, having less regions in the country could also make it easier to cooperate with other regions.

4.8 An analysis of the options

The current situation as described includes some problems and room for improvement. The use of interorganizational architecture could help in achieving the envisaged results. In this section, the model introduced in chapter 2 will be used to analyze different possibilities of using interorganizational architecture.

For each type of architecture, a possible situation within the sector will be given. Using the DYA model again, the three sub-architectures (business, information and technical) will be discussed. The analysis made in chapter 3 will be used to discuss the content and implications of each architecture type in a structured way. Pros and cons will be mentioned from the viewpoint of Brandweer Hollands Midden / the VRHM.

4.8.1 Segment-based architecture

A segment-based architecture would mean that the different partners within the safety region would be placed under the authority of a central organization. This could be for example the board of the safety region. Another option could be to put the various safety regions under the authority of a national organization.

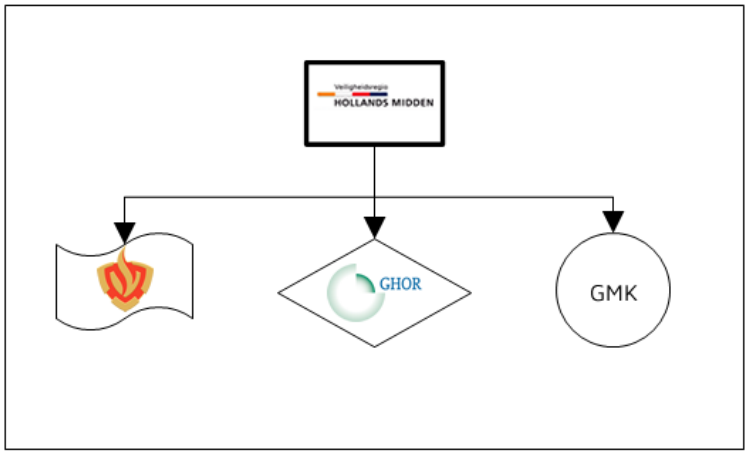

Figure 4.9: Segment-based architecture option (regional)

Looking at the first option, one could see this as a normal situation in which a general board has the control over an amount of subsidiaries, just as would be the case with an authority-based architecture. The difficulty comes with the fact that the subsidiaries in this case would be diverse organizations. Every discipline within the VRHM has its own tasks and its own way of working. They all act as autonomous organizations, and want to stay that way. Putting an authoritative party above them would probably cause a lot of friction.

The content of a segment-based architecture can be very broad. Figure 3.4 shows that everything except for directives on the business architecture could be part of it. Principles and models for the business architecture can help the disciplines build their internal business faster. If the models include information about terminology, communication among the disciplines would be made easier as well. Because of the diversity though, the principles and models would have to stay high-level to still be usable by all the disciplines.

Information sharing within a safety region is very important. It would therefore be a valid option to introduce a shared information architecture, managed by the authority. Data and message standards could improve the interchangeability of data between the various partners. Applications that are used for generic processes like the personnel or financial administration could be set up to be used by all the disciplines. Instead of having someone in each discipline that is responsible for each of these tasks, this could be arranged as a central service. Applications are only purchased once, and data from different disciplines is combined which could lead to better incident preparation, repression, and analysis possibilities.

The technical architecture as part of the segment-based architecture would make sure that the complete

safety region uses the same IT infrastructure. This would also have to be centrally managed. Being connected to the same network would again increase the possibilities of interoperability. It would also be possible to have central registrations in place. Not only the ones with generic data concerning e.g. personnel and finance, but also geographical object data or route information data could be used by all partners if made available at a central location. Because of the information architecture with directives on data standards all partners know what information they can request, and what format it will have.

Putting the different disciplines under the authority of another party will have a serious impact on their autonomy. Since every discipline has always been autonomous, introducing this would cause some resistance. Everyone could always make their own decisions, but now they might be overruled by someone else. Having a central coordination would contribute to the interoperability though, and increase the effectiveness within the subsidiaries and the region. Flexibility for the region will increase, while local flexibility for the disciplines will become less.

An important question when introducing a segment-based architecture in this case is who will fulfill the role of the authoritative organization. The board of the safety region currently isn't concerned with the internal affairs of the several disciplines. Working with a segment-based architecture would mean that they would do so. The members of the current board are majors of municipalities within the safety region. They don't have the practical knowledge that might be useful when having authority over the disciplines. It is therefore questionable whether or not the current board would be suitable for this function. A board formed by people from the various disciplines might work better. It is then important though to also have people in the board that are not directly involved in one of the disciplines, to prevent favoring their own organization when making decisions.

To get the most out of this type of architecture, the GHOR would need to move more towards the safety region. At the moment, its generic processes are executed by the RDOG, while the GHOR is part of the safety region by law. This would make it difficult to set up a segment-based architecture in which the GHOR is fully involved. Non-generic tasks and services like geo analysis and skill registration could still be improved by using such an architecture though.

Another way of presenting a segment-based architecture is by putting the different safety regions in the Netherlands under the authority of a national organization. Such an architecture would be placed a little more to the column on the right when looking at the model on interorganizational architecture. Safety regions could be seen as similar organizations, but from conversations with different regions it becomes clear that regions are quite diverse. The partners that form the safety region, apart from the by law required ones, differ a lot. This influences the way regions work, and makes it harder to come up with an architecture that can be used for these regions.

The question of who would be in charge would again come up. The current national organization, the Veiligheidsberaad, is said to be too little involved with the internal affairs of the safety regions. It wouldn't have the right reputation now to take authority over the safety regions.

The points mentioned when discussing the first type of a segment-based architecture also hold for this type, only on a bigger scale. While the benefits could also be bigger, there are some additional problems linked to this national option. The safety regions are currently being funded primarily by the municipalities in the regions. A national organization laying down rules and principles to be implemented using money from local governments would probably cause some friction. It would be more likely to happen when most of the money came from the national government, as happens with the national police organization.

Another problem would be that projects that are executed throughout the country are big, expensive, and take lots of time. On the one hand having an architecture in place could improve the process of these

projects. On the other hand, enterprise architecture and project management could also clash. Project solutions should fit all the safety regions, and this requirement makes it hard to find the right solution.

A nationally initiated architecture could help support the new NMS system for the emergency call centers. By setting a national basis for the information architecture, every region and every discipline in it would fit the NMS system, which is also a national initiative.

Both types of segment-based architecture could also be combined, creating a layered type of architecture. The national organization could then focus on the national requirements, and the regional organizations on their local issues. This situation is depicted in figure 4.10. Both types of architectures would have a different scope and therefore a different level of detail. The architectures focusing on a specific region would inherit the architecture focusing on all safety regions, and extend this according to the local situation.

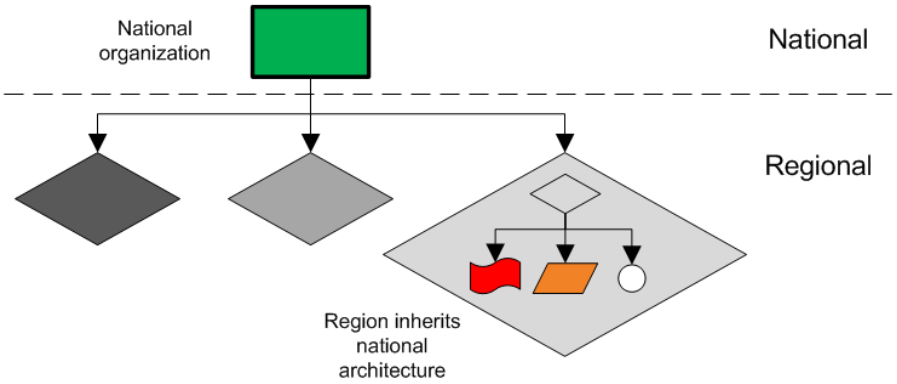

Figure 4.10: Layered sector-based architectures

4.8.2 Authority-based architecture

All the way to the right in the model on interorganizational architecture the authority-based architecture is placed, focusing on similar organizations under a central authority. All regional fire service organizations could be linked under this type of architecture, with an authoritative function assigned to e.g. Brandweer Nederland. Placing similar organizations under an authority does have its pros and cons.

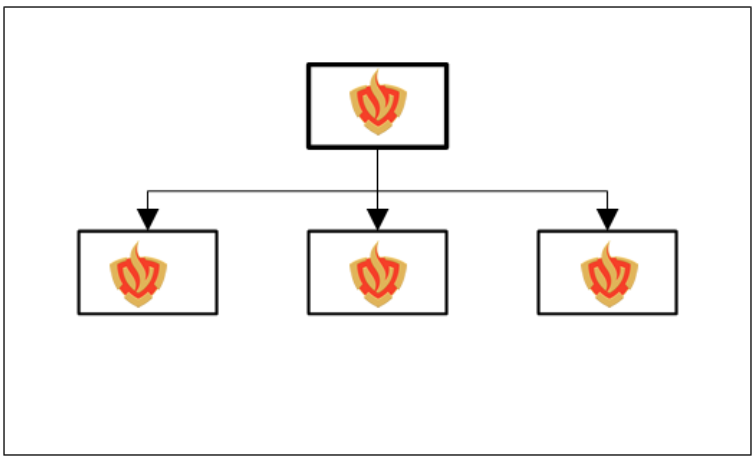

Figure 4.11: Authority-based architecture option

As discussed in the previous section about a segment-based architecture, the autonomy of the different organizations is limited. The question is whether it is good to limit this, because of the diversity of the

organizations. It could be argued that one fire service organization doesn't have other tasks than any other one, but it appears to be different in practice. While one region has to cope with the risks of for example an airport, another one should have knowledge about heath fires. Materials and processes might also be subject to these differences. It could therefore be hard to introduce an architecture that imposes working processes.

An authority-based architecture can include anything a traditional enterprise architecture can include. The business architecture could be quite detailed, but as just mentioned this could also cause problems in the sector. It would though be possible to impose some general processes, for example focused on the generic working processes. Every organization could then use these as a basis and add the specific processes they use themselves. Principles and models from the authority-based architecture could be used to support the process of designing those.

Data and applications used across fire service organizations could be highly standardized, especially the generic and sector-specific applications. Every region has its software to register the competences of its personnel, or make and maintain work schedules for the fire houses. Using the same software or at least data standards would make it easier to share data and thus collaborate. There already have been some initiatives on creating a terminology standard within the sector, these could be extended with data standards.

Imposing a technical architecture could have its benefits, but this would probably have a large impact and cause a lot of problems. Because of the way fire service organizations are now housed, often being in the same building as other disciplines of the safety region, it wouldn't be a realistic option to roll out e.g. a fire service network. Imposing the type of computers each office should use would also barely contribute to the interoperability. Introducing central servers that hold information used by the different fire services could be helpful though. This would mean that not every organization has to do this for itself, which saves resources. The authoritative organization could manage this registration. For this to work every organization needs to use the same data standards, or have the possibility to change the data into the right format. The main problem with such a solution would be that every organization claims that they need the data in some other format than offered, or the information offered is not enough. To (partly) solve this, there should be the possibility to link the core registration to some additional local registration, working according to the same standard. The question then though is whether the benefits of having a core registration are still applicable.

All using the same applications would mean that these applications could also be bought as one organization, but another problem is at hand then. When tendering for an application as a national organization, there won't be a lot of possible providers. This means there would be less competition, and thus prices would go up while the amount of options to choose from would decrease.

Because of the way safety regions are organized at the moment, it could cause problems when introducing an architecture focused on one of the disciplines. Collaboration with the other disciplines could get more difficult because of this, and managers could get accountable to two different organizations. It should therefore be a conscious decision to focus on the single discipline. The management by a national organization would help to align the different fire service organizations and make them work more efficient.

The results discussed in section 3.3 also mention that it is hard to innovate. In the current situation it already is a problem to implement projects with a broad scope (i.e. for a lot of regions) because of the demands of all the concerned parties. This makes them expensive and often these projects take a long time. Having an organization that lays down the architecture could make it easier because of the authority it has, but of course this should be used wisely.

An authority-based architecture could also be introduced as a downsized version, for example only focusing on the generic processes. Local information managers will always remain necessary on the regional level to manage the local processes. Core registrations should be managed by personnel from the national organization.

4.8.3 Chain architecture

The segment-based architecture focused on the different disciplines under the authority of a central organization or board. Without that authority, it would be a chain architecture. The different disciplines would work under an architecture that is based on loose coupling, while retaining the autonomy of the disciplines. This type of architecture could be designed as a local solution for one region or as a national solution to be used by all the safety regions. Most of the benefits and drawbacks of a segment-based architecture also hold for a chain architecture, except for the ones caused by the presence of an authoritative entity. The differences between both types will be discussed in this section.

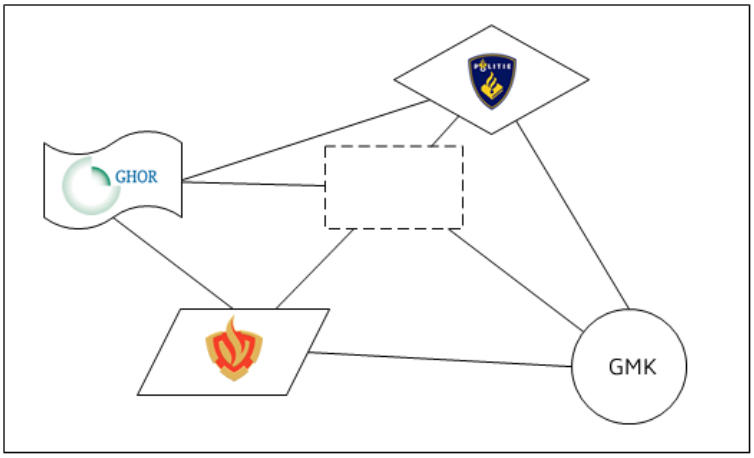

Figure 4.12: Chain architecture option

Loosely coupled systems work in such a way that they don't know how the other systems work. Interfaces are defined that are used by multiple systems. Systems used by the different disciplines are able to communicate and share information, but are not physically linked. This leaves the possibility for the disciplines to make their own choices when it comes to the used software, as long as the software fits the data interchange standards.

Because of the missing authority, the business architecture part of a chain architecture doesn't include policy directives. This means working processes could be different for each discipline, even the generic ones. Principles and models could be used to support the process design.

The information architecture could include the same level of detail as in a segment-based architecture. It is the most important part when it comes to loose coupling. Without agreeing on some data or message standards, it wouldn't be possible to set up good interoperability between systems. Sharing information would still be difficult. General applications like personnel and finance could be agreed on, as already mentioned when discussing the segment-based architecture. The maintenance of these applications should then be done by one of the disciplines.

Impose a technical architecture doesn't fit the idea of loose coupling. Principles and models on this part could support the information architecture though, for example by describing the use of a specific operating system or network protocol. Core registrations could be established, but these should also be administered by one of the disciplines. Using chain registrations could be a better option, leaving all the

information at the different partners, but making sure everyone is able to share and get the information they need at all time.

By remaining autonomous the different disciplines keep acting as separate disciplines and less as a part of the safety region. This is good when thinking about the recognition by citizens. The 'fire department' organization is more known to everyone than the safety region. A drawback in this case is the difficulty concerning projects that affect multiple disciplines. These often take a lot of time, and missing an authoritative organization doesn't make it easier. Having no architecture at all makes it even harder, because there is no common basis for the projects.

Another problem of this type of architecture could be the managerial complexity. In case there is no board that manages the architecture, every decision concerning it has to be made by representatives of the different disciplines. They then have multiple interests, being the architecture (better for the collaboration) and their own discipline (better for themselves).

In case there would be the need for another partner to collaborate with (e.g. the RUD's) the disciplines within the safety region, a chain architecture is more easily extended. It is often designed in such a way that it is usable by diverse organizations, and it is easy to adopt the architecture.

Just like the segment-based architecture the chain architecture could have a national scope. This would mean that the national organizations would implement an architecture. Although chain architectures focus on diverse organizations, the national organizations are too different and have other interests. This would mean that the level of detail would be very low, as would the benefits of the architecture. It wouldn't therefore be a good option. Better could be to have a reference architecture on the national level. This option will be discussed later.

4.8.4 Sector architecture

The fourth type of architecture that could be used for Brandweer Hollands Midden is the sector architecture (similar organizations, autonomy retained). This type focuses on connecting the different fire service organizations in the Netherlands without the interference of an authoritative organization. It is again based on loose coupling. Most of the pros and cons of the authority-based architecture also hold for a sector architecture, so only the differences will be discussed here.

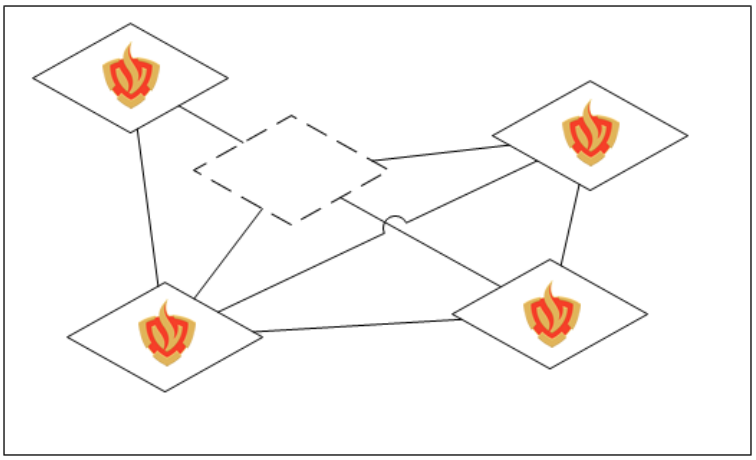

Figure 4.13: Sector architecture option

Looking at the content of a sector architecture (figure 3.10) the main difference with an authority-based architecture lies in the technical part. A sector architecture for fire service organizations could include

some principles on the network or platforms used, but won't lay down any specific rules on this topic. This supports the idea of loose coupling. Principles and (some) directives on applications and data are more likely to be included. Standards would be most likely to be used, so that every organization can adapt itself to these standards, without losing its autonomy.

Principles, directives and models could support process standardization within the fire service sector. To remain autonomous organizations won't accept prescribed processes, but frameworks or reference models could help support the internal model-making process.

Applications used by the organizations could be adapted to the standards on data and messaging to improve the interoperability and the ability to share information. Core registrations are more difficult to put in place, because of the absence of the authority. Chain registrations could be a better option. Trying to share information as simple as possible (thus supported by standards etc.) could partly fill the need for shared information.

As discussed earlier, fire service organizations sometimes have other focus areas or knowledge about special objects. It could be useful to introduce a sector architecture for a smaller group of organizations with the same area of focus or within a certain geographical region. For example BHM with the fire department of Haaglanden and Rotterdam Rijnmond (number 17 in figure 4.4) By doing this it would be easier to go more into detail on certain topics and come to an agreement on the architecture content faster. A drawback however is that the chance an organization would have to comply with more than one architecture would increase (e.g. a national architecture on safety regions and a regional architecture).

4.8.5 Reference architecture

Reference architectures can be used to guide fire service organizations or (disciplines of) safety regions while making their own architecture. The VeRA architecture is already doing so. It focuses on the safety regions without interfering with the internal business. This reference architecture can be used when designing a more specific architecture.

The pitfall of using reference architectures is the absence of any form of authority. Organizations may use a reference architecture if they like it, but may put it aside as well. It is easier though to create a reference architecture for a bigger scope. That is why it could be useful to create a reference architecture for the safety regions (as is the VeRA) or for the fire service organizations. The organizations keep their autonomy but may adapt to a national standard. It's also easier for other organizations to comply with a reference architecture in case they would need to cooperate with safety regions.

As explained in chapter 3 a reference architecture can be seen as a high-level version of one of the other types. Benefits could be less, but freedom to choose whether to comply or not remains.

Having a reference architecture will often be better than having no architecture at all. A reference architecture can have quite some benefits, as shown in figure 3.3. The question remains what area to focus on when designing a reference architecture.

4.8.6 An overview

The architectures discussed before are focusing on two main actors: the VRHM and BHM. To create an overview of the benefits of each type of architecture for both of these actors, the different characteristics were placed in a table. Then, based on the analysis in the previous sections these were mapped to BHM and the VRHM. The goal is to further show what type of architecture might be best suited for what actor.

Figure 4.14 shows which characteristics of the different types of architecture are applicable or useful to

	RA	SBA	ABA	CA	SA		BHM	VRHM
Improved collaboration with partners	x	x	x	x	x		x	x
More clarity	x	x	x	x	x		x	x
Increased standardization	x	x	x	x	x		x	x
Create an holistic view	x	x	x	x	x		x	x
Change the organization	x	x	x	x	x		x	x
Improved working process	x	x	x	x	x		x	x
Increased efficiency	x	x	x	x	x		x	x
Cost reduction	x	x	x	x	x		x	x
Might be too high-level	x							
Not prescriptive	x						x	
Increased global flexibility		x		x			x	x
Improved interoperability		x		x			x	x
Support primary processes		x		x			x	x
General starting point		x		x			x	x
Application integration		x		x				x
Increased effectiveness		x		x				x
Limited local flexibility		x						x
Limited autonomy		x						x
Integrated service delivery			x		x			x
One image to outside world			x		x		x	
Auto-comply with regulations			x		x		x	
Difficulty of being bounded by different rules			x					
Hard to implement			x					
Hard to innovate			x					
Integrated information supply				x				x
Complementary service delivery				x				
Information integration				x				x
Governance might be an issue				x				x
Support internal model-making process					x		x	
Interference with internal architecture					x		x	

Figure 4.14: Characteristics from the different architecture types.

	RA	SBA	ABA	CA	SA
Total	*10*	*16*	*14*	*18*	*13*
BHM	9	12	10	12	12
VRHM	8	16	9	17	9

Figure 4.15: An overview of the characteristics suitable for BHM and the VRHM.

the two parties. A cross in the row of a negative characteristic means that it isn't a problem in that case. The table in figure 4.15 shows an overview.

The green cells indicate the architectures that have the most matching characteristics with the situation at BHM or the VRHM. A reference architecture has, as expected, a lot of characteristics that are useful in both situations. As discussed earlier, a reference architecture can be used in almost any situation that concerns a structured collaboration.

For BHM the architecture type with the most matching characteristics is the sector architecture. The segment-based type would also be suitable, looking at the numbers, but because this architecture focuses on diverse organizations, it is not an option. An authority-based architecture does focus on similar organizations, but as discussed earlier in this chapter, it might have its drawbacks.

The VRHM shows the most connecting factors with the segment-based architecture and the chain architecture. The main difference between these two is the presence of an authoritative entity. This aspect was further discussed in previous sections.

In the next section, the analysis in the previous sections and the overview given in this section will be

combined to introduce an advice on the use of interorganizational architecture for BHM and the VRHM.

4.9 Advice

The advice given in this section is based on all previous information discussed in this chapter. It focuses on the long-term developments, i.e. the coming 5 years. Developments discussed in section 4.7 are taken into account when possible. The advice answers the question about with whom BHM should design an interorganizational architecture, and what should be in it.

BHM has a lot of partners to cooperate with. Not only the partners within the safety region have such a role, but other fire service organizations in the country could also be worth cooperating with. This makes it a complicated situation for BHM.

The safety region VRHM is the main organization BHM is working in. All disciplines within the VRHM have the same (geographical) focus area and are working in the same environment. The fact that the VRHM has legal obligations to fulfill certain tasks and contain certain disciplines makes it reasonable to put the primary focus on this organization. Future developments might include the merging of safety regions, but such organizations will persist to exist.

Fighting fires is a complicated job, as are the other tasks of the fire department. The amount of difficult and dangerous situations in which firefighters could have to work is high, and each and every one asks for its own approach. To be prepared for every situation, the 'cold' preparation is just as important. A bad preparation could lead to wounded people or worse.

The information technology nowadays allows us to share digital information very fast and efficient. Smart information systems can help organizations organize data, and transform it into usable information. Combined with the fact that a lot of organizations, and especially governmental ones, have to reduce expenses, this creates possibilities. Making smart use of technology to support cooperation between organizations while saving money. Interorganizational enterprise architecture can help design these collaborations and support interoperability and information integration.

This advice includes two types of architecture. One focuses on the interoperability within the VRHM. The other one looks at the fire service organizations. As mentioned in the analysis of the various options (section 4.8) having to comply with multiple architectures might cause problems for an organization. It is therefore important to have only one architecture that is imposed. Other architectures may focus on specific parts that are not part of the imposed architecture, to further develop the collaboration with partners. An overview of the recommended situation is shown in figure 4.16.

4.9.1 VRHM: segment-based / chain architecture

Within the VRHM, the current collaboration with partners in cold situations is minimal. Every discipline, except for the BGC, has its own generic processes and applications. Documents are shared when necessary, but stable information systems that include data usable by multiple parties are absent. A lot of benefits could be gained when changing this situation.

Introducing a combination between a segment-based architecture and a chain architecture in the VRHM would make sure that the generic processes that disciplines are now separately working on are put into a central part of the organization. Because of the diversity of the disciplines it is not wise to impose discipline-specific processes. Autonomy when it comes to the specific businesses should be maintained. A central authority put in place could manage the generic parts of the organization, including the linked registrations. This would give the disciplines more time to focus on their own specific business. As

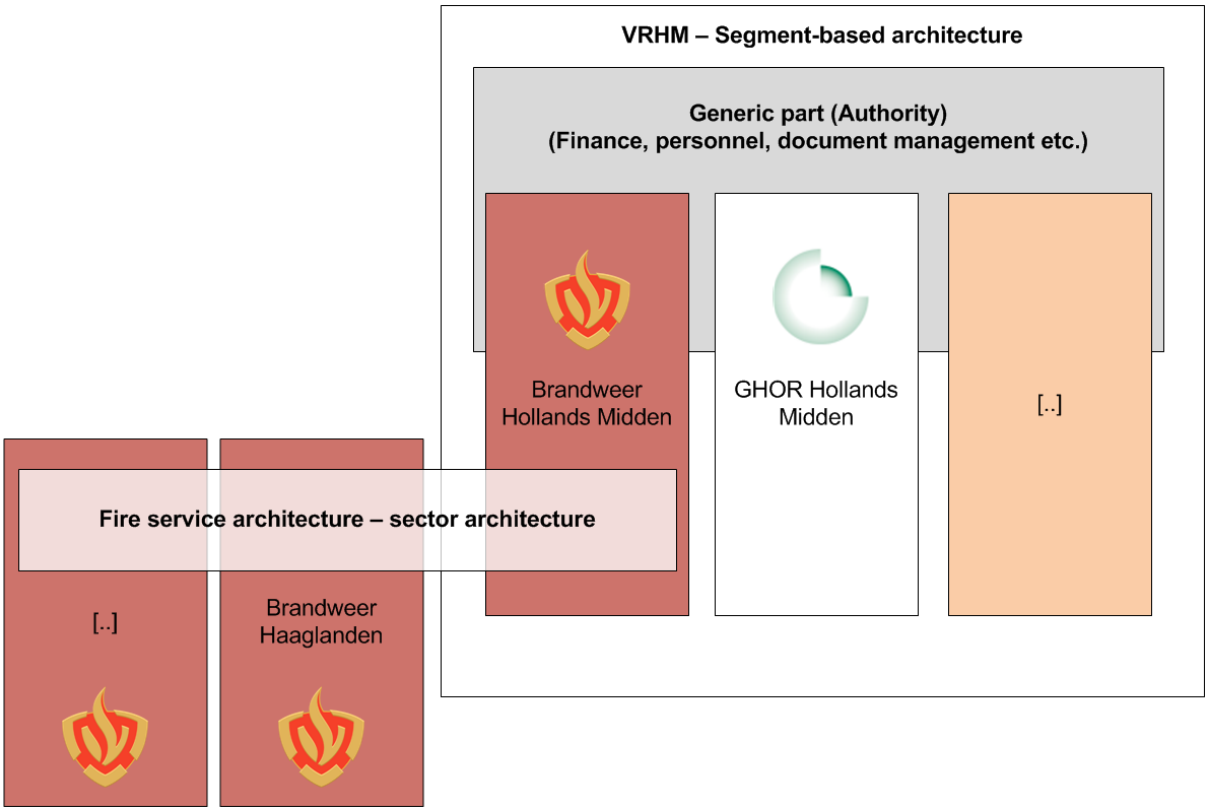

Figure 4.16: The proposed situation for BHM / VRHM

previously mentioned the best results could be reached when the GHOR moved more towards the safety region so that more functions could be centralized.

Some non-generic functions could be centralized too. BHM as well as the GHOR are working with the application AG5 to register competences and incidents. This application thus could be put on a central server as one environment and be used by the different disciplines. The new applications DBK and RIS could have a broader scope. While it would be slightly more difficult to make these suitable for multiple disciplines, not sharing that information would be a waste of resources. Using the same information system makes it easier to share information and cooperate with the other partners. Having only one system per (generic) function for the whole safety region would save time and money.

The specific applications, services and business processes should be managed by the responsible disciplines. That way it would also be easier to comply with any sector-specific architectures or protocols, and local freedom is retained. Of course the applications would have to fit the technical architecture.

While a segment-based architecture has the disadvantage of taking away the autonomy of the organizations, it does contribute to greater benefits because the architecture is implemented for sure. An authoritative organization that wisely uses its position can make the organizations benefit a lot from the architecture. The same holds for the proposed architecture. Because the authority only focuses on the generic part of the organizations, benefits can be gained from this part, while retaining the local freedom at the disciplines.

As discussed in section 4.6, the VeRA reference architecture focuses on interoperability within and between safety regions. It could be used as a basis for the architecture within VRHM. If all regions would have an architecture built on the same basis, interoperability would indeed be easier because the architectures are probably more alike. Adding an extra focus on the fire department discipline would

make things even better for Brandweer Hollands Midden because safety regions would pay attention to the way fire service organizations work (together).

4.9.2 Fire service organizations: sector architecture

As already mentioned, fire service organizations have to cope with a lot of complex material. Their preparation and prevention tasks are as important as the repression. Having the right information available at the right moment is very important. Knowledge is also an important asset required for the job. Acquiring all the knowledge yourself when it is already available at another region would be a waste of time. Therefore it would be recommendable to make agreements on the way data is stored or processes are designed. An architecture could help structuring this information. This would best be done on a national scale to increase the effect. Knowledge on specialties of certain regions wouldn't have to be part of this architecture, but could be adapted to comply with general guidelines.

Because in this case the concerned organizations are similar, the architecture would be a sector architecture, focused on the fire service organizations. Principles and models on the business architecture could be used to create a light form of process standardization within the sector. The information architecture could include standards on data en messages, to improve the possibilities of information integration. Looking at the introduction of the NMS / LMO, including agreements on data formats and organizational issues would make it easier to comply with these standards. Complying with the sector architecture would mean complying with the NMS standards.

Application standards would probably be less useful to include. One could argue that using the same software for scheduling or incident registration would be beneficial for the interoperability, but it is more of an internal matter. It would be extra useful if geographical information used within the safety region complied with a set standard as well. Due to the diverse requirements of every region this would be hard to realize though, especially when the data is also used for other disciplines in the region.

Technical aspects would probably conflict with the technical architecture within a safety region, and it would therefore not be a good idea to include them in the sector architecture. In case a sector-specific (national or multi-regional) system would be put in place, having a technical framework to use could have its benefits though.

Introducing a sector architecture focused on the fire departments would thus contribute to process and data standardization in the field of fire service organizations. This supports interoperability and makes it easier to share information. Sharing information means that organizations need to gather less information themselves, saving resources.

4.9.3 Managerial issues and organizational barriers

A general problem of enterprise architecture is that it might not be directly visible what the benefits are. Especially when proposing an architecture that causes an organization to loose part of its autonomy. Within BHM and the VRHM this is no different. It is therefore very important to involve the management in the process of designing and implementing an architecture. If they don't support it because they don't see the added value, it won't work.

In the case of BHM, the organization is already established and part of the VRHM. This might make it more difficult to adapt to an architecture, especially because it introduces an authority. Organizational change is always a challenge, and it will take some time. By explaining where the organization is going to and involving the right people, the transition would be smoothened.

Chapter 5

General principles

Chapter 2 and 3 focused on introducing and analyzing a model on interorganizational architecture that was used in a case study described in chapter 4. After discussing this specific situation, some general principles will be outlined in this final chapter. These principles can be used in any industry when looking at opportunities of using interorganizational architecture. Of course, they should be checked against the environment at hand.

The given principles are derived from the information in the previous chapters, and thus based on literature, documentation and interview data referenced before. The case study also supports the principles described. They could be seen as a conclusion of this thesis, giving an overview of the discussed matter.

5.1 When and why to use interorganizational enterprise architecture?

In section 2.2.2 several drivers for the use of interorganizational architecture were discussed. These drivers could be seen as further specifications of one main driver: having a structured form of collaboration with one or more other organizations. This could therefore be the trigger for designing and implementing an interorganizational architecture. Using the architecture type with the least direct impact, a reference architecture, does already deliver great benefits for all partners.

Start looking at interorganizational architecture in case of a structured collaboration.

Short-term collaborations are less suited to be supported by an interorganizational architecture. This is because of the time it takes for an architecture to get implemented. They could possibly be supported by a project architecture, focused on the specific collaboration.

Long-term or structural collaborations would be benefited by an interorganizational architecture. The type and level of detail of such an architecture would depend on the type and length of the collaboration. The lengthier the process, the more it would pay off to implement an architecture. Structural collaborations are therefore most suited for this type of solution.

Long-term collaborations might be better suited for interorganizational architectures than short-term ones.

An organization consisting of business units could also be seen as a form of structural collaboration. While some organizations might have an enterprise architecture that focuses on the different business

units, other organizations use separate architectures for each unit. These would benefit from creating an interorganizational architecture because it would help improve the integration.

Interorganizational architecture can also be used to connect different business units.

5.2 With who to implement an interorganizational architecture?

A lot of organizations collaborate with multiple organizations at the same time. Some are similar organizations, some are of another type or another industry. As previously mentioned, while the one collaboration might be temporary, another one could be more structural and long lasting. The question is which organization(s) to collaborate with supported by architecture.

Assuming a collaboration is structural, it would be easier to design an architecture that focuses on likewise organizations. The architecture could include more detail, and therefore deliver greater benefits. A possible problem might be that small differences between the organizations are seen as required for an organization, and therefore hinder the use of an architecture.

An architecture for similar organizations can include more detail. The similarity has to be recognized by the organizations for the architecture to deliver benefits.

A lot of collaborations will include multiple partners that are not similar. While creating an architecture for diverse organizations could be more difficult because of the various interests and environments, it will more often be done because the need for standardization between these organizations is higher.

An architecture for diverse organizations can deliver great benefits, but will probably focus primarily on standardization.

The bigger the amount of organizations included in an architecture, the more difficult it might get to reach a certain level of detail. It is therefore wise to only include those organizations that really are part of a structured collaboration. Partners that sometimes are included in a project could better be given a reference architecture (because of the generality) or a project architecture (focusing on that specific project at hand).

For the sake of focusing on the right thing, only include the most important partners in the development of an interorganizational architecture.

5.3 What should be in such an architecture?

The question on the content of an interorganizational architecture could be seen as the question regarding what type of architecture to use. Each type of the model introduced in section 2.2 has its own characteristics when it comes to content. These are just guidelines though, and other implementations are possible as well.

The content of a reference architecture could be seen as a minimum of the content to be included. This depends on the areas of focus though, and the relevant architecture layers in a certain situation. Based on

the applicable quadrant within the model, this content can be extended. In case of a central authority, it is possible to include more detailed parts, and when looking at similar organizations the architecture could include a full description of (parts of) an organization.

Using a reference architecture can already deliver great benefits. The type of architecture used depends on the situation at hand.

Working with diverse organizations could cause the architecture to include less detailed information, with the exception of the data integration part. Having a central authority would support more detailed architectures, but when such an authority is absent an architecture should stay out of the internal matters of the concerned organizations and focus on retaining their autonomy. The introduction of a central authority in an environment that is not used to one could cause a lot of problems.

An authoritative entity can add value to an architecture, but should only be in place when suitable for the situation.

Implementing an architecture that includes a lot of details takes more time than a high-level one. It is therefore very important to realize what level of detail is needed in which situation.

Reference architectures could be used on a very broad scale. Every type of collaboration, short-term, long-term or structural, should have a reference framework. This makes sure that the concerned organizations work on the same architectural basis.

Implementing architecture can take a lot of time. Starting with a small (reference) architecture can be a good start for further developments.

5.4 How do you implement an interorganizational architecture?

Although it is somewhat outside the scope of this thesis, it is worthwhile looking at some aspects of the implementation of an interorganizational architecture. Without the right approach it could completely miss its target.

If the board of a company doesn't recognize the value of (enterprise) architecture, introducing an architecture that goes beyond organizational borders will be very hard. The organization should be aware of the added value of complying with an architecture. Projects should fit the applicable architecture, just as other developments within an organization.

Recognition of the possible value of enterprise architecture is a requirement for the design and implementation.

An organization that has its own enterprise architecture should be willing to adapt some of it to comply with an architecture with a bigger scope. There will always be organizations that don't automatically fit an interorganizational architecture, otherwise there wouldn't be the need for one. Adapting could become difficult if an organization has to comply with more than one interorganizational architecture.

Be willing to change. Stubbornness will thwart the efforts put into an architecture.

Being a part of different chains at the same time is thus also a possible problem. An organization should have only one imposed architecture. The collaboration in other chains could still be supported by architecture, but such an architecture should not have an authority that needs organizations to comply.

Complying with more than one architecture could get difficult. Watch for conflicting architectures.

The model on interorganizational architecture combined with these principles should help managers get insight in the possibilities of interorganizational architecture and act as a guide when designing and implementing the support for collaboration.

Bibliography

[1] AUSTIN, J. E. Strategic collaboration between nonprofits and business. *Nonprofit and Voluntary Sector Quarterly 29*, suppl 1 (2000), 69–97.

[2] BERRE, A.-J., ELVESÆTER, B., FIGAY, N., GUGLIELMINA, C., JOHNSEN, S. G., KARLSEN, D., KNOTHE, T., AND LIPPE, S. The athena interoperability framework. In *Enterprise Interoperability II*. Springer, 2007, pp. 569–580.

[3] BOER, R., SCHIJVENAARS, T., AND OORD, E. Referentiearchitecturen in de praktijk. *Via Nova Architectura* (2011).

[4] CHALMETA, R., CAMPOS, C., AND GRANGEL, R. References architectures for enterprise integration. *Journal of Systems and Software 57*, 3 (2001), 175–191.

[5] COUNCIL, C. A practical guide to federal enterprise architecture, 2001.

[6] GALASKIEWICZ, J. Interorganizational relations. *Annual review of sociology* (1985), 281–304.

[7] GRAY, B. Conditions facilitating interorganizational collaboration. *Human relations 38*, 10 (1985), 911–936.

[8] GREEFHORST, D., GREFEN, P., SAAMAN, E., BERGMAN, P., AND HARMSEN VAN DER BEEK-HAMER, T. W. Referentie-architectuur: off-the-shelf architectuur, 2008.

[9] HARDY, C., PHILLIPS, N., AND LAWRENCE, T. B. Resources, knowledge and influence: The organizational effects of interorganizational collaboration*. *Journal of Management Studies 40*, 2 (2003), 321–347.

[10] HENDERSON, J. C., AND VENKATRAMAN, N. Strategic alignment: Leveraging information technology for transforming organizations. *IBM systems journal 32*, 1 (1993), 4–16.

[11] KRUISWIJK, B., AND POELS, R. *Digitale architectuur*. Eburon Uitgeverij BV, 2012.

[12] LAENEN, J., AND VENNEKENS, I. Succesful chain integration through architecture, 2011.

[13] LANKHORST, M. *Enterprise architecture at work: Modelling, communication and analysis*. Springer, 2013.

[14] LI, H., AND WILLIAMS, T. J. The interconnected chain of enterprises as presented by the purdue enterprise reference architecture. *Computers in Industry 42*, 2 (2000), 265–274.

[15] LINTHICUM, D. S. *Enterprise application integration*. Addison-Wesley Professional, 2000.

[16] OF THE DOD CIO, O. Reference architecture description, 06 2010.

[17] OLIVER, C. Determinants of interorganizational relationships: Integration and future directions. *Academy of management review 15*, 2 (1990), 241–265.

[18] PANETTO, H., JARDIM-GONCALVES, R., AND MOLINA, A. Enterprise integration and networking: theory and practice. *Annual Reviews in Control* (2012).

[19] PFEFFER, J. A., ET AL. *The external control of organizations: A resource dependence perspective*. Stanford University Press, 2003.

[20] ROSS, J. Maturity matters: How firms generate value from enterprise architecture. *Research Briefing, CISR, Sloan School of Management, MIT 4*, 2B (2004).

[21] ROSS, J. W., WEILL, P., AND ROBERTSON, D. C. *Enterprise architecture as strategy: Creating a foundation for business execution*. Harvard Business Press, 2006.

[22] RUGGABER, R. Athena-advanced technologies for interoperability of heterogeneous enterprise networks and their applications. *Interoperability of enterprise software and applications* (2006), 459–460.

[23] SCHÖENHERR, M. Towards a common terminology in the discipline of enterprise architecture. In *Service-Oriented Computing–ICSOC 2008 Workshops* (2009), Springer, pp. 400–413.

[24] (TOGAF), T. O. G. A. F. Togaf 9.1, 12 2013.

[25] WAN, H., LUO, X., JOHANSSON, B., AND CHEN, H. Enterprise architecture benefits. *ICISO 2013* (2013), 62.

[26] WILLIAMSON, O. E. Markets and hierarchies: antitrust analysis and implications. *New York: The Free Pres* (1975).

[27] WOOD, D. J., AND GRAY, B. Toward a comprehensive theory of collaboration. *The Journal of Applied Behavioral Science 27*, 2 (1991), 139–162.

Appendix A

Analysis process: tagging

Figure A.1 gives an overview of the tags used during the analysis of the interviews.

Figure A.2 shows an excerpt of the transcription of an interview that shows the method of tagging it.

In figures A.3 and A.4 two examples of tagclouds used to analyze the interviews and documents on architectures are given.

Category	Sub	Tag	Tag#
1	Terminology used	Enterprise architecture	1.1
		Reference architecture	1.2
		Domain architecture	1.3
		Chain architecture	1.4
		Middle architectures	1.7
		Technical architecture	1.8
		Information architecture	1.9
		Network organization	1.12
		Business architecture	1.13
2	Content of architecture	Business layer	2.1
		Application layer	2.2
		IT layer	2.3
		Physical IT system(s)	2.4
		Authorization / authentication	2.5
		Broker system	2.6
		Reference process	2.7
		Interfaces	2.8
		Guidelines (non-prescriptive)	2.10
		Reference descriptions	2.11
		Agreements	2.12
		Principles	2.13
		Starting point	2.15
		Network	2.16
		Chain-wide components	2.17
		SLA	2.18
3	Data	Transaction process	3.1
		Data sets	3.2
		Disclosing of data	3.3
		Integration of data	3.4
		Editing of chain data	3.5
		Sharing of data	3.6
		Usage of shared data	3.7
		Linked with external registrations	3.8
		Feedback system for registrations	3.9
		Chain registrations	3.10
		Single data retrieval	3.11
		Stays at the source	3.12
4	Standards	Usage	4.1
		Message standards	4.2
		Data standards	4.3
		Application standards	4.4
		Service standards	4.5
		Process standards	4.6
		Not compliant with external standards	4.7
		Security standards	4.8
		Open standards	4.9
5	Negative effects	Hard to change	5.1
		Hard to implement	5.2
		Limited choice because of size difference	5.3
		Political discussions	5.4
		Hard to innovate	5.5
		Bounded by different rules	5.6
6	Applications	External applications influencing chain data	6.1
		Own applications by partners	6.2
		Central application(s) for the sharing of data	6.3
		Same application used by different partners	6.4
		Applications adapted to fit in architecture	6.5
8	Approach	HOW-question addressed	8.1
		EA Framework used	8.2
		TOGAF method	8.3
		ArchiMate	8.4
		SOA thinking	8.5
		Loose coupling	8.6
		Mission / vision of party's taken into account	8.7
		Agreements based on legislation	8.8
		Translate policy into architecture	8.9
		Retain autonomy	8.10
		Disconnect processes / businesses	8.11
		No central strategy used during development	8.12
		Rik Maes	8.13
		Business oriented	8.14
		Open model	8.15
		Same architectural basis for parties	8.16
		It's about politics	8.17
		Architecture as toolbox	8.18
9	Documentation	Wiki	9.1
		Comprehensive for non-architects	9.2
		Targeted at managers	9.3
10	External connections	Alignment with other architectures - method	10.1
		Connecting with other architectures - interfaces	10.2
		Connection with other networks	10.3
11	Goals / effects	Collaboration between partners	11.1
		Holistic view	11.2
		Clarity	11.3
		Integrated information supply	11.4
		Integrated service delivery	11.5
		Complementary service delivery	11.6
		Change the organisation	11.7
		Flexibility	11.8
		Decrease administrative burden	11.9
		Cost reduction	11.10
		Improved working process	11.11
		Support primary process(es)	11.12
		Efficiency	11.13
		Standardization	11.14
		Application integration	11.15
		Information security	11.16
		Comply with regulations	11.17
		Structure	11.18
		Effectiveness	11.19
		Decision making process	11.20
		One image to outside world	11.21
		Knowledge sharing	11.22
		Support internal model-making processes	11.23
		Generate value for the business	11.24
		Alignment business and IT	11.25
12	Other	Architecture as one piece	12.1
		Driven by politics	12.2
		Smaller architecture is better	12.4
		Reuse of other architectures	12.5
		Often changing	12.6
		Driven by stakeholders	12.9
		Driven by law	12.10
13	Governance	Central managing party	13.1
		Parties are allowed to deviate	13.2
		No justification to controlling party	13.3
		Parties are limited in their choices	13.4
		Supported by law	13.5
		Free to join, no obligations	13.6
		Obliged to follow	13.7
16	Scope	No focus on organizations' internal matters	16.1
		Focus on borders	16.2
		Coincides with internal policies	16.3
		Possibilities for other sectors	16.4
17	Extending	Linking a new party is a lot of work	17.1
		Linking a sortwise party is simple	17.2
		Linking a new source is a lot of work	17.3

Figure A.1: The tags used for analyzing the interviews

Excerpt from one of the interviews with tags

Zorgverleners kunnen doorwerken bij uitval van LSP, dus autonomie?

Volledige autonomie.	8.10		
Het is de maximale vrijheid die je als zorgverlener hebt om zelf voor je applicatie te kiezen, zelf voor je leveranciers te kiezen, zelf te kiezen voor de manier waarop het eigenlijk wordt ingericht.	6.2		
Wij kijken bijvoorbeeld niet naar de interface.			
We geven wel advies, maar schrijven niets voor.	2.10		
Het zijn open standaarden, het zijn koppelvlakken, het zijn algemene richtlijnen over (beveiligings)standaarden, beveiligingsniveaus die je moet halen, om deel te mogen nemen.	4.9	2.8	4.8

Resultaten

Om te beginnen is het een enorme slag in de beveiliging die we aan het maken zijn.	11.16		
Daar loopt de gezondheidszorg aardig achter.			
Gezien de privacygevoeligheid van de informatie die er is.			
De gezondheidszorg moet aan wet- en regelgeving voldoen daar, die moet aan die NeN norm voldoen.			
Daar helpt het bij als je toetreedt tot deze infrastructuur.			
Het brengt de applicaties op een hoger niveau, en de organisaties daar omheen.			
Je gaat in één keer de sprong maken dat je aan de wet- en regelgeving voldoet.	11.17		
Inhoudelijk is het een structureren.	11.18		
Wat je met dat HL7 ziet is dat je interpretatieverschillen of problemen voorkomt.	11.14		
Dus je gaat van ongestructureerd verkeer, platte tekst, aantekeningen, ga je naar gestructureerde informatie, naar zaken die ook geautomatiseerd ingelezen kunnen worden.	11.13		
Ook mechanismen om intelligenter te toetsen bijvoorbeeld.			
Dus dat je heel veel gegevens door kan om signalen te destilleren, bijvoorbeeld of iemand een probleem heeft met een bepaalde medicatie.			
Dus je ziet dat er minder interpretatieproblemen ontstaan, bij de waarneming, en aan de andere kant dat er veel meer informatie beschikbaar is om te voorkomen dat iemand de verkeerde behandeling ondergaat.	11.3		

Figure A.2: An excerpt of the transcription of an interview

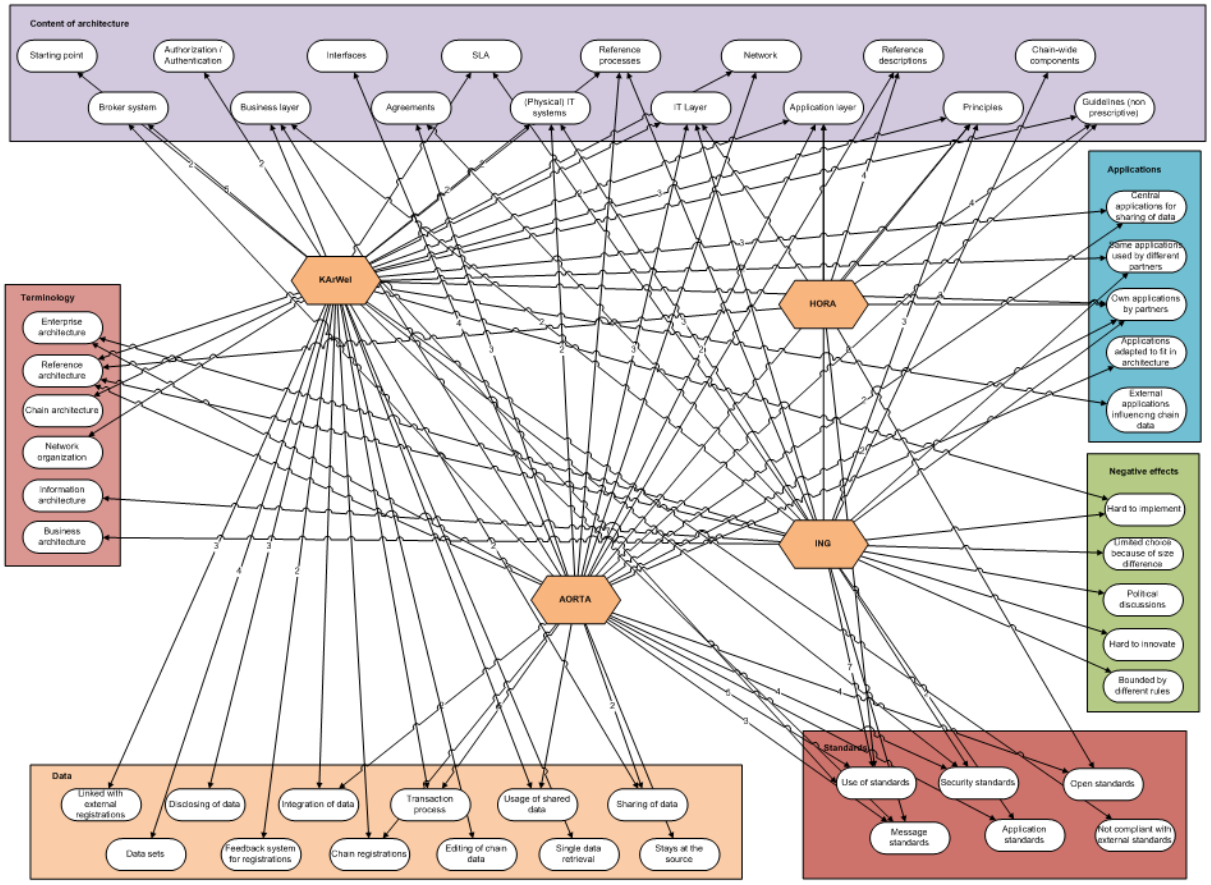

Figure A.3: One of the tagclouds used to analyze the interviews and documents on architecture

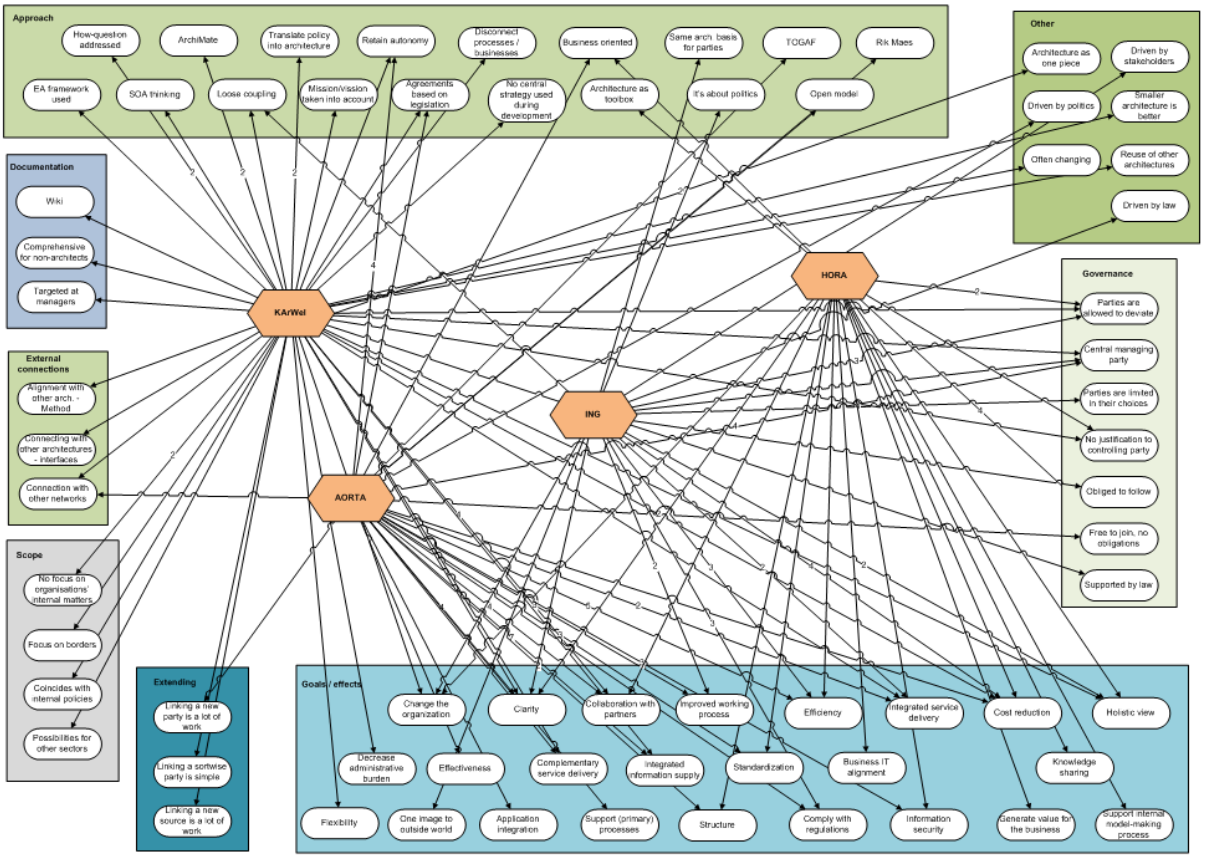

Figure A.4: One of the tagclouds used to analyze the interviews and documents on architecture