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Measuring the efficiency offered to local e-Governments by Service Oriented Architectures

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PREFACE

Municipalities are increasingly responsible for implementing national laws in a local context and offering these as digital services to the citizens, as a result they need to develop numerous and complex software systems to implement these e-services. The SAS-LEG project proposes to use a Service Oriented Architecture solution to implement the law once and offer it as a customizable service to several municipalities.

This thesis is aimed at developing and applying measures for determining increased efficiency offered to local e-Governments by Service Oriented Architectures. Quantitative measures follow from considerations regarding return on investment and potential for reuse. Qualitative measures are specific to the Dutch e-government objectives.

The Dutch Government Reference Architecture (NORA) defines the specific demands placed by the Dutch government on all ICT projects. These demands are modelled in the form of main e-Government principles, each in turn consisting of several derived principles. The general nature of these NORA principles means that they represent a high level of abstraction.

Qualitative measures are therefore developed by condensing demands from NORA into specific e-Government objectives. The measures defined in this thesis are subsequently applied to the research areas of the SAS-LEG project in order to determine if they are achieved.

ACKNOWLEDGEMENTS

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Adam Loorbach

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1 Introduction

Starting in 1994 the Dutch authorities have shown an increased interest in e-Government and multiple ambitious projects have been undertaken to enable electronic delivery of services to citizens and businesses. For example the 'Actieprogramma Andere Overheid' aimed for a 25% reduction in the administrative burden, offering 65% of all government services over the internet and provide 24/7 availability. Another important goal being that personal data has to be provided only once to the government, after which it can be used by all relevant government organizations and services. These ambitions have subsequently been taken over by the most recent e-Government initiative: NUP ('Nationaal Uitvoeringsprogramma dienstverlening en e-overheid'). This initiative has set NORA ('Nederlandse Overheid Referentie Architectuur') [NORA] as the standard reference architecture for all government organizations and places a strong focus on national coordination and cooperation by means of a Service Oriented Architecture. A SOA describes a set of patterns and guidelines for creating loosely coupled, business-aligned services that provide unprecedented flexibility in responsiveness to new business threats and opportunities [Arsan 04]. A change in policy currently taking place in the Netherlands is the shifting of tasks and responsibilities from the national government back to the municipalities, thus limiting the involvement of the national government in day-to-day affairs of its citizens. This increased the workload and responsibilities of municipalities and creates the potential for a lot of redundancy when similar processes are implemented amongst hundreds of municipalities.

1.1 The SAS-LEG Project

Software As Service for the varying needs of Local e-Governments [SAS-LEG] is a joint project of the University of Groningen, Cordys and local municipalities of the north of the Netherlands. The SAS-LEG project proposes to use the Software as Service (SaS) principle to implement a law once and offer it as a customizable service to several municipalities [Aiello 10] [Bulanov 09]. This is basic research funded by the Dutch National research council (NWO) in its software engineering programme (Jacquard). The WMO law will be used a testbed for technologies developed during the project.

1.2 Test-Case: The Dutch WMO law

The Dutch WMO law ('Wet Maatschappelijke Ondersteuning') was introduced in 2006 in order to place the responsibility for providing support of elderly and disabled persons in the hands of the local governments. This includes providing home-modifications, wheelchairs, means of transportation and

housekeeping assistance. The law is established at the national level, but the detailed implementation (within constraints) is left to the 430 municipalities in the Netherlands.

1.3 Research Question

This thesis is focused on the evolution of local e-Government, specifically on possibilities stemming from the Service Oriented Architecture paradigm. Past e-Government projects have resulted in a multitude of different systems and as the e-Government grows, this scattered IT landscape is becoming increasingly difficult and costly to expand. The SOA paradigm has a history of increasing importance throughout the years, since maturing IT systems and infrastructures allow organizations to utilize the full benefits it offers. Recognizing the potential benefits, the Dutch government has begun pursuing the SOA approach by actively promoting its implementation. The SAS-LEG project is currently spearheading new developments in the area of Service Oriented Architectures specifically aimed at local e-Governments. This thesis will deal with the question of how its success (i.e. improved efficiency) can be demonstrated.

The main research question of this thesis then becomes:

> "How can the SAS-LEG project, which allows municipalities to implement national laws in a local context, be used to demonstrate that using the Software as Service (SAS) paradigm leads to increased efficiency for local e-Governments?"

To answer this question, the following sub-questions need to be answered:

- What is the current status of local e-Government in the Netherlands?
- How does the Service Oriented Architecture approach fit into local e-Government?
- How can improved efficiency in local e-Government be measured?
- How does the SAS-LEG project demonstrate increased efficiency for local e-governments?

To answer these questions, a list of quantitative and qualitative measures has been constructed based on an analysis of the principles put forward in the Dutch government reference architecture NORA. These measures have subsequently been applied to research performed during the SAS-LEG project to determine if they are achieved.

1.4 Contribution

The contribution of this thesis is to offer a method of quantitatively and qualitatively assessing the benefits of a Service Oriented Architecture implementation for the Dutch e-Government. It shows how research currently being undertaken in this area can be linked directly to the requirements of the Dutch government reference architecture and achieve its objectives.

1.5 Thesis Organization

This thesis is divided into four parts. The first part focuses on the status of local e-Government in the Netherlands. It shows the history of local e-Government and the demands and objectives that lead to its current state of affairs. The Dutch e-Government reference architectures on both the national and municipality level (NORA, GEMMA) will be outlined.

The second part focuses on developments in the area of Service Oriented Architecture and the benefits it provides to potential e-Government implementations. It also shows where and how a Service Oriented Architecture approach is pursued by the Dutch government. This forms the answer to the second sub-question.

The third part focuses on measuring efficiency improvements provided by SOA implementations. It will contain a literature study on quantitative measures to determine Return on Investment of SOA projects. Qualitative measures will be extracted from an analysis of NORA, by determining the requirements for increased efficiency within the Dutch e-Government approach.

The fourth part is centred on the SAS paradigm, it details where it expands on the SOA paradigm and the areas of improvement it is spearheading. It will describe the activities at the Business, Architecture and Service levels and the tools used at these levels. It will also describe the engineering processes and quality attributes that form the basis of a Software as Service implementation. This part will show how improved efficiency can be demonstrated using the measures resulting from the literature study. This final part answers the last sub-question. The subsequent conclusion explains how the main research question is answered by the sub-questions which can be traced throughout the thesis.

2 What is the current status of local e-Government in the Netherlands?

2.1 Introduction

This chapter gives an overview of the status of local e-Government in the Netherlands. It will show the history of e-Government initiatives that lead to the current state of affairs, as well as the objectives and demands that are driving its developments. Special attention will be given to the most recent initiative and the reference architecture (NORA) in which it is outlined. The sectoral reference architecture for local e-Governments (GEMMA) is also outlined, in particular its relation and differences with regard to NORA.

2.2 Local government in the Netherlands

Government in the Netherlands is divided into three layers: national government, provinces and municipalities. The national government is formed by the ministries and the government organizations they employ and is responsible for matters like national defense, justice and immigration. There is also a division into twelve provinces, they handle the responsibilities too large for municipalities and too small for the national government, as a result of this, their contact with citizens is limited. Examples of their work areas includes the environment, infrastructure and transportation, culture and economy. Municipalities form the third layer of the government and are responsible for executing the national laws. They have a large degree of autonomy when it comes to the services they provide, only limited by the constraints placed by the national government. As of 18 March 2010 the Netherlands consists of 430 municipalities, ranging from small communities (<1000 people) to large cities (>700.000 people). An overview of the division into provinces and municipalities can be seen in *figure 2-1*.

Figure 2-1: Overview of provinces and municipalities in the Netherlands

2.3 History of Dutch e-Government initiatives

Dutch e-Government initiatives date back as far as 1994, with the most recent one commencing in 2008. This section will provide an overview of the e-Government initiatives undertaken thus far according to [elo 05].

1994 – Nationaal Actieprogramma Elektronische Snelwegen
Initiative to acquire a leading role in ICT for the Dutch Government, objectives included large-scale ICT projects to serve as an example. The role of the Dutch government was as a large-scale user of information systems and not as a provider of online services.

1996 – Overheidsloket 2000
An attempt to focus the previous program on the future by inviting businesses to state demands for the quick introduction of 'electronic highways' aimed at demand-driven services offered to the Dutch population. This included early development of tools for a virtual counter and recognising the need for connecting front and back-offices.

1998 – Actieprogramma Elektronische Overheid
Aimed at promoting the use of ICT in various areas of government organizations and institutions. Goals included the electronic availability of the government, better public service and improved internal operations of the government.

1999 – De Digitale Delta Nederland oNLine
Aimed at creating a climate of flexibility and adaptability, partial in response to a motion that various e-government initiatives threatened to create a scattered ICT landscape. Five pillars essential to the national IT basis were defined: telecom-infrastructure, knowledge and innovation, access and skills, judiciary, and the deployment of ICT in the public sector. These pillars needed to be integrated to a single coherent policy.

2000 – Contract met de toekomst
This program constituted the start of the large scale implementation of the Dutch e-Government. Budgets were made available for e-Government projects within all municipalities and government organizations in order to fulfil the goals of the program, which included websites for all municipalities offering government information to the population. It also aimed to establish expertise- and governance organizations to monitor and promote the progress of the e-Government and enable the collection and sharing of best practices.

2002 – Beter Beleid voor Burger en Bedrijf
A short lasting program following the turbulent elections in 2002, caused by the assassination of political leader Pim Fortuyn and the changed social and political climate afterwards. Aimed primarily at using ICT for a more efficient and effective government, but ended within 3 months after the fall of the cabinet and new elections.

2003 – Actieprogramma Andere Overheid and ICTAL
New program aimed at a complete restructuring of the government, where the government dictates less rules and citizens gain more responsibility. The government set out four new objectives: improve service to the citizens, reduce the number and type of affairs the government regulates, better organization of the government itself and renewal of the relationships between the government and local municipalities and provinces. To enable these objectives, the ICTAL (ICT administrative burden-reduction) programme was launched to develop ICT support for cooperation between government and companies.

2006 - Op weg naar de elektronische overheid
Addition to the previous program, introducing new objectives: 65% of all government services offered over the internet, citizens only have to provide their personal data once, after which it is available to all relevant government organizations. The Government will use open standards, both for internal and external communications.

2008 - Nationaal Uitvoeringsprogramma dienstverlening and e-overheid (NUP)
The latest e-Government program, which forms the basic infrastructure for the realisation of the e-Government. Nineteen building blocks consisting of government e-services, example projects and information tools for citizens and businesses. This program sets NORA ('Nederlandse Overheid Referentie Architectuur') as the standard reference architecture for the entire government. NORA also serves as the norm for specific sectoral architectures like municipalities (GEMMA), but also provinces (PETRA), water management (WILMA) and ministries (MARIJ). [e-overheid]

2.4 Dutch Government Reference Architecture (NORA)

NORA (Dutch Government Reference Architecture) stems from the most recent e-Government initiative of the Dutch government and lays the foundation for the IT architecture of the Dutch e-Government. It takes demands placed on the government by civilians, companies and international treaties, and combines these into a set of fundamental principles to which all implementations of e-government systems should adhere. These principles include demands on the Business architecture, Information architecture and Technical architecture of individual systems, but also include the way these systems should operate together by means of a Service Oriented Architecture approach as

defined in NORA (called SGA). All together there are 20 main principles and about 140 derived principles. The NORA objectives are aimed at achieving the following goals:

- Higher quality of service
- Lessening the administrative burden
- Transparency
- Proactive service
- Integral and reliable government
- Enhancing government functioning

2.4.1 NORA fundamental principles

NORA is based on a number of sources to form fundamental principles that set the workings of the government, this section will provide an overview of the various programmes that led to the fundamental principles that make up the core of NORA.

2.4.1.1 Objectives 'Andere Overheid'

Conclusions and recommendations from the 2003 action program 'Andere Overheid', divided into thirteen objectives:

- Higher quality of service
- 65% services offered over the internet
- One-stop shopping, no endless referrals
- One-time providing of personal data, multiple reuse
- Digital identity, electronic signature
- Less rules
- 25% reduction in administrative burden
- Better organization national government
- New division of tasks: more effective, transparent and efficient
- Better regulation, detecting and reducing fraud
- Government renews relationships with provinces and municipalities
- Governance of process chains
- Benchmarks

2.4.1.2 Wishes from the business community

Results from the ICTAL program aimed at establishing wishes from business community:

- Reduction of regulations
- One-time providing of personal data, multiple reuse
- Use of base-registrations
- Optimal deployment of ICT in process chains

2.4.1.3 Objectives 'Informatie op Orde'

Conditions for the proper administration of both paper and electronic databases of the government:

- Information has to be findable
- Information has to be accessible
- The government guarantees the reliability, authenticity and completeness of her (digital) information
- Government information has to be interchangeable between government organizations
- Government organizations have to make agreements about information administration from the collection to the destruction of information

2.4.1.4 Wishes from citizens

Discussions with panels consisting of citizens led to the creation of the Citizens Service Code:

- Freedom of contact channel (front desk, letter, phone, e-mail, internet)
- Findable government services (one-stop shopping)
- Understandable services (rights and duties are clear)
- Personal information service (government provides information based on personal situation)
- Easy service (proactive services based on one-time provided personal information)
- Transparent operation (government updates citizens on running procedures)
- Digital reliability (government has affairs in order and guarantees confidentiality)
- Accessible government (openness to complaints and suggestions)
- Responsible governance (benchmarks are made available)
- Active involvement (participation by citizens is enabled and stimulated by the government)

2.4.1.5 European Interoperability Framework Principles

European framework defines eight principles for cooperation:

- Accessibility
- Multi-lingual
- Security
- Privacy
- Subsidiarity
- Open standards
- Open source software
- Multilateral solutions

2.4.1.6 Fundamental Principles

All these reports and programmes are condensed into a single list of 20 fundamental principles that make up the core of NORA:

P1. Services are offered over the internet
P2. Existing channels remain available
P3. No wrong door
P4. One stop shopping
P5. A single administrative identity
P6. Regularly scheduled checks
P7. Transparent and accessible complaint procedures
P8. Information only requested once
P9. Aiming for minimal administrative burden
P10. Simple rules and regulations
P11. Inform on progress of the process
P12. Transparent, traceable service processes
P13. Periodic reporting on responsibilities
P14. Make available general government information
P15. Visible process
P16. Point to relevant services
P17. Consistent and reliable government
P18. Data is accurate, actual and secured
P19. Use of generic building blocks
P20. Standardize and optimalize

2.4.2 NORA Architecture

2.4.2.1 Hierarchy of Reference Architectures

NORA is part of an hierarchy of reference architectures (Figure 2-2), with international standards and the European Interoperability Framework on the top and Sectoral Reference Architectures and Business Reference Architectures at the bottom. This means that NORA adheres to international standards as well as the European Interoperability Framework, while Sectoral Reference Architectures like GEMMA adhere to NORA.

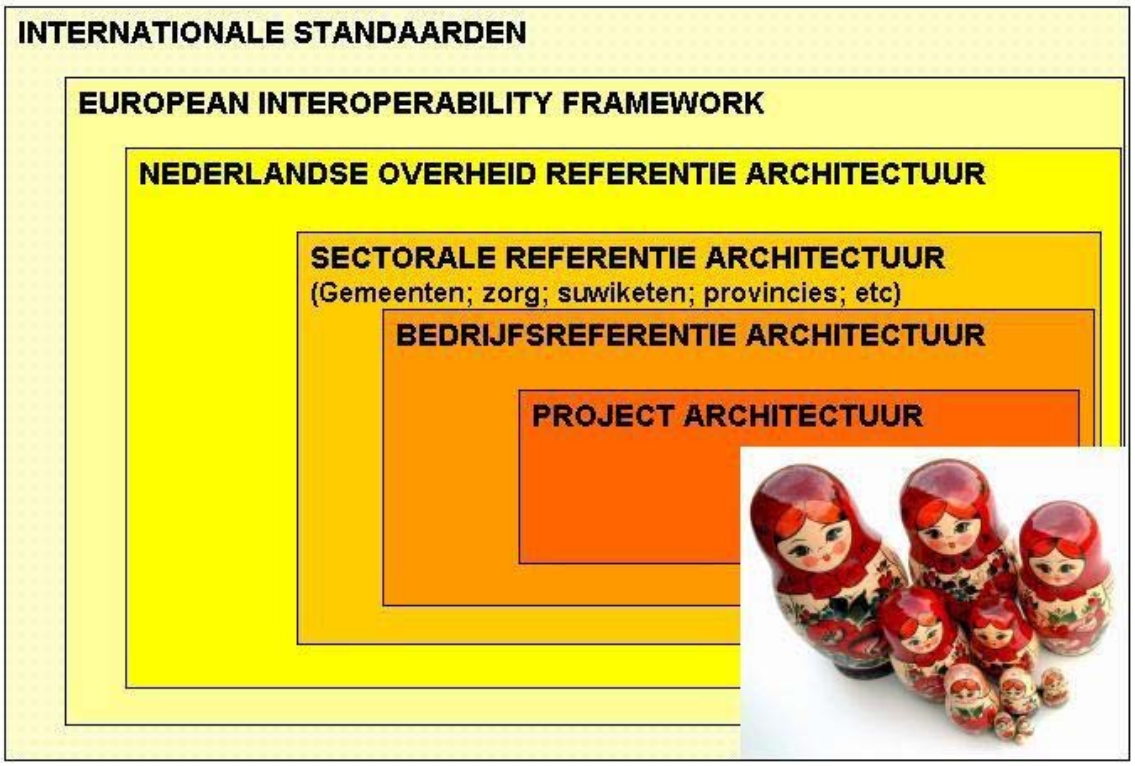

Figure 2-2: Hierarchy of Reference Architectures

2.4.2.2 Architecture Framework

The NORA architecture framework consist of three layers of architecture (Figure 2-3):

- Business architecture
- Information architecture
- Technical architecture

Furthermore the framework contains three columns:

- 'Who' takes action?
- 'What' is delivered?
- 'How' is this done?

Finally there are two generic dimensions: security and governance, which affect all three layers. In NORA this framework is used to represent the architectural principles. Two basic architectural decisions cannot be not represented in a single cell, these refer to the semantical architecture and the service oriented architecture approach. The semantical architecture deals with interoperability between e-Government services when it comes to semantics, the approach towards the service oriented architecture forms a major part of this thesis and is analysed in the next chapter. [NORA]

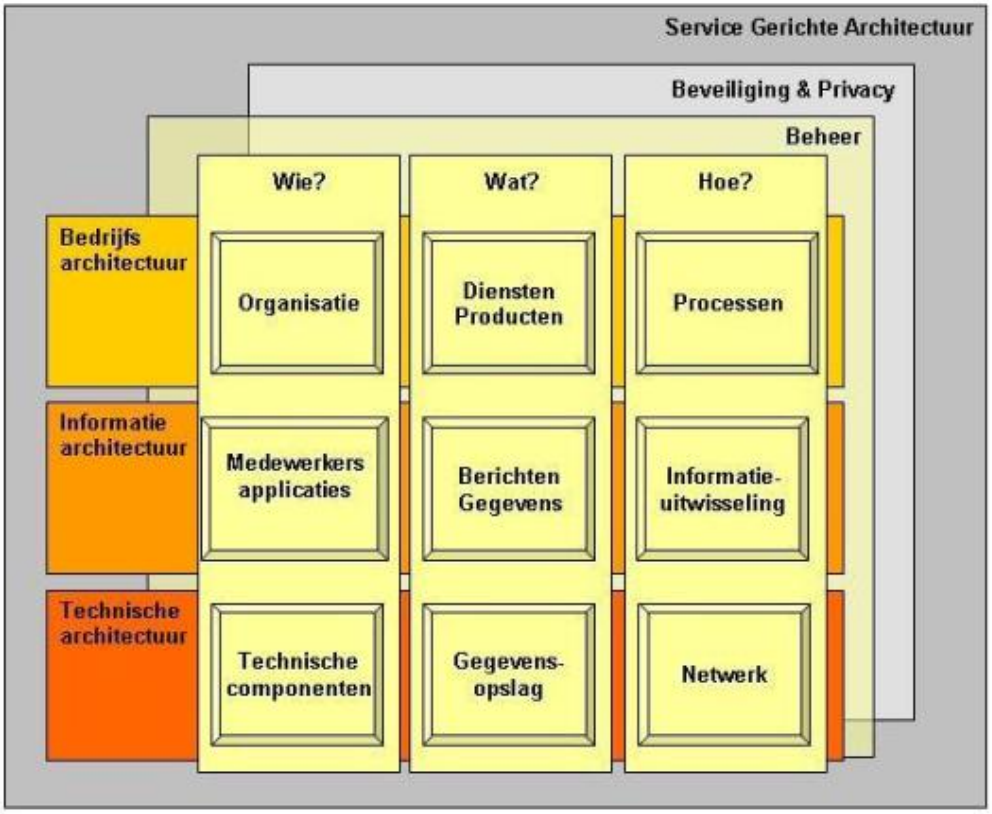

Figure 2-3: NORA Architecture Framework

2.5 Municipality Reference Architecture: GEMMA

GEMMA is the reference architecture for implementations at the municipality level. It derives most of its requirements from NORA and adds requirements that are specific to municipality level implementations. As the SOA approach defined by NORA is intended to be uniform on a national level, GEMMA does not state additional requirements to the SOA approach. This section will provide an overview of GEMMA requirements and their relevance to the SAS-LEG project.

2.5.1 GEMMA Process Architecture Principles

GEMMA states seven main themes and principles which form the basis of the process architecture:

- Case- and Process oriented operations
- Maintaining and using databases with citizens' data
- Separation between governance of processes and back office tasks
- Municipality develops into the standard portal to the government
- Connect with e-Government services developed under NUP
- Cooperation at the process level with organisations in the public sector and government
- Growth to service oriented processes

2.5.1.1 Process architecture model for service delivery

GEMMA defines five roles (customer, customer-contact, service-manager, specialist and process-chain partner) along with nine process building blocks (intake, delivery, manage, govern, decide etc.) which together can be used to model service processes like in Figure 2-4.

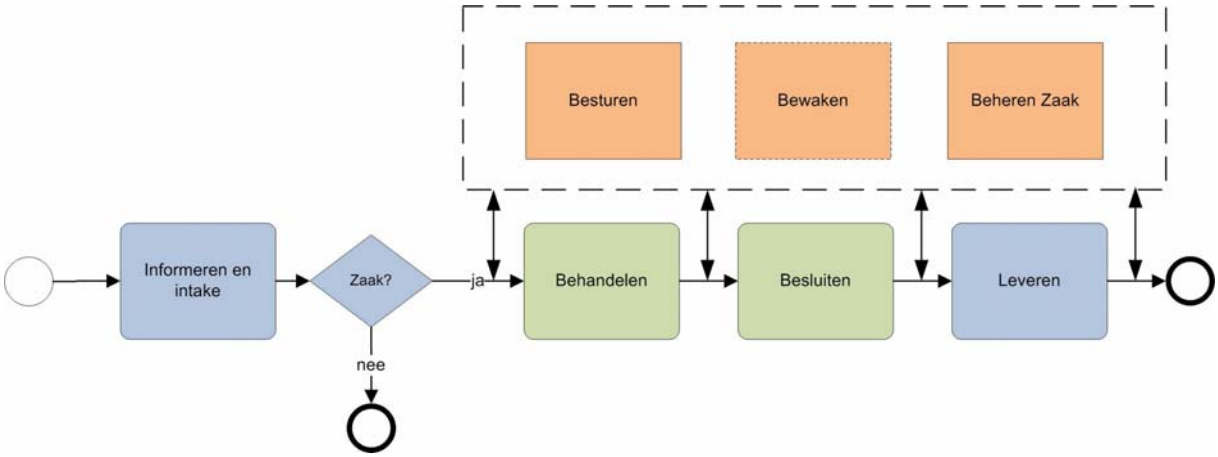

Figure 2-4: GEMMA modelling of service processes

2.5.2 Differences with regard to NORA

As seen in the reference architecture hierarchy, GEMMA adheres to NORA. GEMMA is specifically aimed at the processes taking place at the municipality level, roles and process building blocks are defined towards this specific environment, whereas NORA is much broader. GEMMA does not define additional requirements for the service oriented architecture but focuses on the creation of service processes from a business point of view.

2.6 Summary

This chapter has shown that the Dutch government has undertaken a large number of e-Governments initiatives dating back to 1994. The most recent project (NUP) is currently underway and established NORA as the standard reference architecture for the Dutch government. This chapter has also provided an overview of the objectives and demands that form the basis of the Dutch e-Government initiative and shown how this is outlined in NORA. The relation between NORA and GEMMA has been explained and the analysis showed that GEMMA takes its SOA requirements directly from NORA without introducing new SOA requirements.

3 How does the SOA approach fit into local e-Government?

3.1 Introduction

This chapter deals with the developments of the Service Oriented Architecture approach and the link to e-Government. It will provide an overview of the attributes and advantages of the SOA paradigm and show how and where the Dutch government is pursuing a SOA approach.

3.2 Principles of a Service Oriented Architecture

Service-oriented computing is the computing paradigm that utilizes services as fundamental elements for developing applications [Papazo 03]. See Figure 3-1 for a sketch of a typical SOA environment.

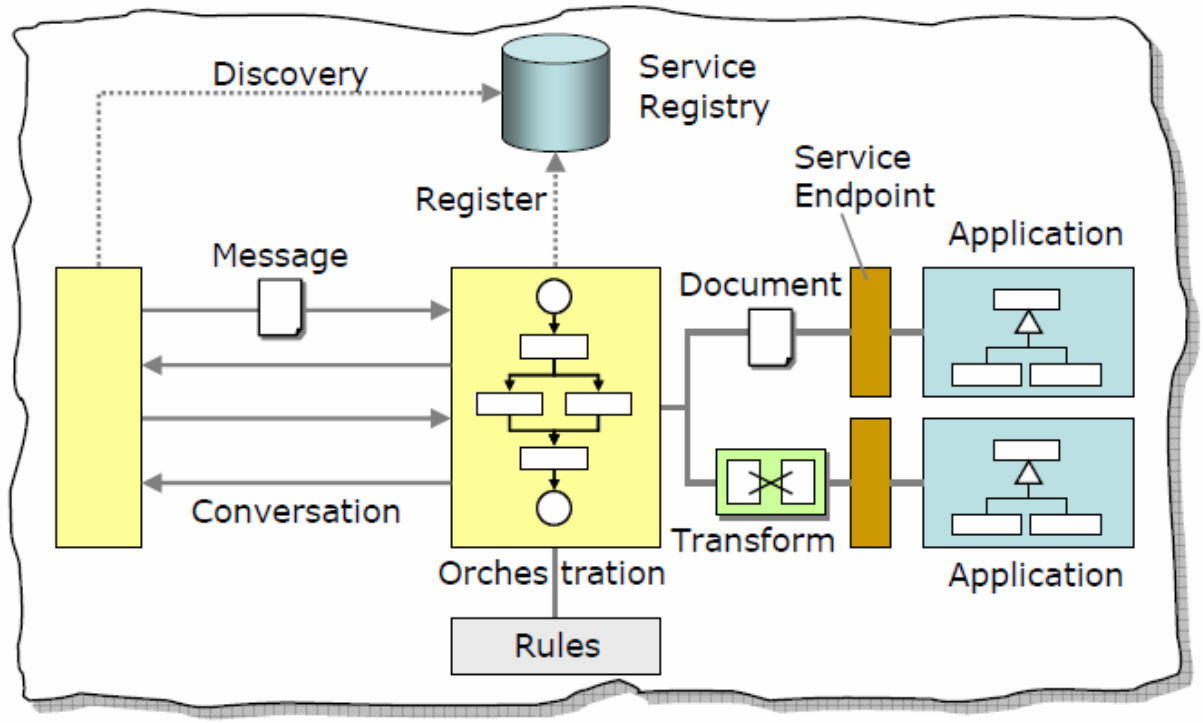

Figure 3-1: SOA sketch [Hohpe 07].

Services

Services are self-describing, open components that support rapid, low-cost composition of distributed applications. Services are offered by service providers—organizations that procure the service implementations, supply their service descriptions, and provide related technical and business support. A Web service is identified by a URI, whose service description and transport utilize open Internet standards. Interactions between Web services typically occur as SOAP calls carrying XML data content. Interface descriptions of the Web services are expressed using Web Services Definition Language (WSDL) [Papazo 03]. Service are loosely coupled, reusable and context independent.

Service registry

The Universal Description, Discovery, and Integration (UDDI) standard defines a protocol for directory services that contain Web service descriptions. UDDI enables Web service clients to locate candidate services and discover their details. See Figure 3-1 for an UDDI interaction diagram.

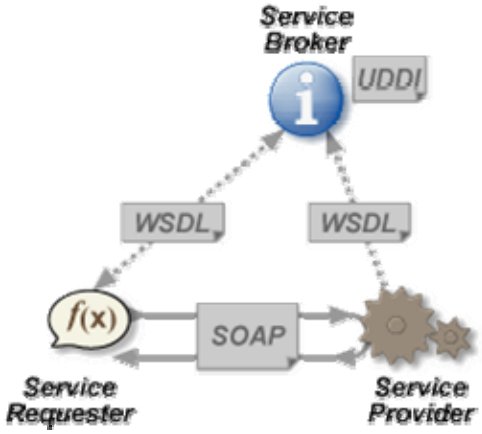

Figure 3-1: Service discovery and integration

Service orchestration and choreography

A choreography is a model of the sequence of operations, states, and conditions that control the interactions involved in the participating services. The interaction prescribed by a choreography results in the completion of some useful function. A choreography can be distinguished from an orchestration. An orchestration defines the sequence and conditions in which one Web service invokes other Web services in order to realize some useful function [W3C].

SOA Architectural layers

The relationship between services and components is that enterprise-scale components (large-grained enterprise or business line components) realize the services and are responsible for providing their functionality and maintaining their quality of service. Business process flows can be supported by a choreography of these exposed services into composite applications. An integration architecture supports the routing, mediation, and translation of these services, components, and flows using an Enterprise Service Bus (ESB). The deployed services must be monitored and managed for quality of service and adherence to non-functional requirements [Arsan 04]. Figure 3-3 shows an overview of the SOA architectural layers.

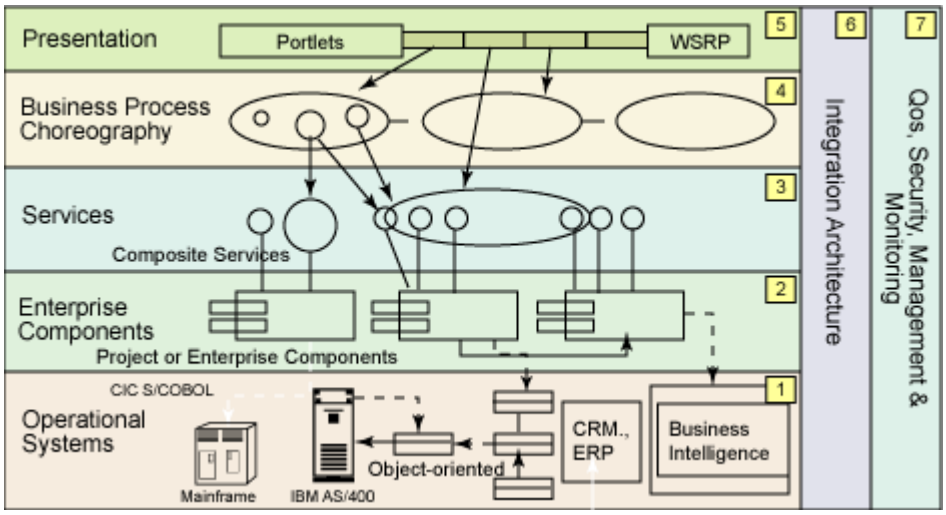

Figure 3-3: SOA architectural layers[Arsan 04].

Layer 1: Operational systems layer. This consists of existing custom built applications, otherwise called legacy systems, including existing CRM and ERP packaged applications, and older object-oriented system implementations, as well as business intelligence applications.

Layer 2: Enterprise components layer. This is the layer of enterprise components that are responsible for realizing functionality and maintaining the QoS of the exposed services.

Layer 3: Services layer. The services the business chooses to fund and expose reside in this layer. They can be discovered or be statically bound and then invoked, or possibly, combined into a composite service. The interfaces get exported out as service descriptions in this layer, where they are exposed for use. They can exist in isolation or as a composite service.

Layer 4: Business process composition or choreography layer. Compositions and choreographies of services exposed in Layer 3 are defined in this layer. Services are bundled into a flow through orchestration or choreography, and thus act together as a single application. These applications support specific use cases and business processes.

Layer 5: Access or presentation layer. SOA decouples the user interface from the components and ultimately an end-to-end solution from an access channel to a service or composition of services has to be provided.

Layer 6: Integration (ESB). This layer enables the integration of services through the introduction of a reliable set of capabilities, such as intelligent routing, protocol mediation, and other transformation mechanisms, often described as the ESB.

Layer 7: QoS. This layer provides the capabilities required to monitor, manage, and maintain QoS such as security, performance, and availability. This is a background process through sense-and-respond mechanisms and tools that monitor the health of SOA applications.

3.3 Dutch e-Government drive towards Service Oriented Architecture

One of the main challenges of NORA results from the subsidiarity approach: the focus is placed on agreements that are necessary for entire system of e-Government to function together, internal aspects of individual implementations and organizations are interfered with as little as possible. To achieve this, there is a strong focus on collaboration points between different parts. A collaboration point is not merely the exchange of messages, but rather the request of some service and the resulting feedback. Therefore the decision has been made to pursue a service oriented architecture approach (called 'SGA') which also corresponds closely with the NORA objective of the government as a provider of services.

3.3.1 NORA Service Gerichte Architectuur (SGA) principles

The Dutch governments' drive towards a Service Oriented Architecture is established in five principle objectives of the "Service Gerichte Architectuur" (SGA).

Transparent responsibilities, open architectures

Services are offered trough transparent interfaces, without revealing their inner workings. These interfaces are offered to potential users. This results in open and professional architectures.

Outside-in Design

The design of internal parts is based on the services that will be offered within the SGA environment. During design, services from other parts may be utilized.

Disconnection

During cooperation between vendors, tension always exists between binding agreements and desire for autonomy and freedom of operation. Services will be used in order to maximize interoperability while at the same time minimizing dependencies.

Reusability

Government organizations can offer their services to multiple users. In order to make this possible, service providers should place the minimal amount of demands on the use of their services.

Situational and context independence

In many cases it is important to note in which situations or context data is exchanged or used. Personal data may only be exchanged when this serves a specific purpose, when designing messages it is often necessary to know the context in which the message content is used. Specific naming of services enables the explicit stating of purpose and context, messages are meaningless when taken out of this context.

3.3.2 NORA Service Gerichte Architectuur (SGA) main elements

NORA defines an architecture as service oriented when it complies with the following four main elements.

Design approach

In a SGA the architecture components - the services - are explicitly defined and form the starting point for further development of the components.

Publication and Service level agreement

Clear service definitions are available for potential users. When a service is being used, a mutually binding service level agreement is established.

Standardize

In a SGA, services form the method of collaboration, not the message. This means that messages are not developed as being independent, but rather in the context of the service in which they are used. At the technical level, international open standards like ebXML and Webservices are employed.

Busses

When delivering services, architecture components are supported by a service bus which fulfils neutral communication functions and also provide rich functions like a service registry and monitoring of service levels.

3.4 Summary

This chapter has given an overview of the SOA paradigm and the Dutch Government Reference Architecture NORA. Analysis of NORA clearly shows how the Dutch government is actively promoting the SOA paradigm by defining it as a set of fundamental principles to be applied in all government related ICT projects.

4 How can improved efficiency in local e-Governments be measured?

4.1 Introduction

Before improved efficiency can be demonstrated, it is necessary to determine how improved efficiency can be measured, this chapter contains a literature study towards this objective. First a distinction will be made between quantitative and qualitative measures followed by a more detailed analysis of both. The quantitative measures are relatively generic will be analysed using metrics obtained in practice by companies like Oracle and the MITRE Corporation. The qualitative measures are specific to the Dutch e-Government demands and will be analysed by extracting them from NORA.

4.2 Differentiation between quantitative and qualitative measures

When analyzing Return on Investment decisions it is necessary to note a distinct difference between commercial enterprises and government organizations. Whereas enterprises are primarily concerned with determining monetary returns, a government organization also has to consider social implications. The MITRE Corporation is a not-for-profit organization chartered to work in the public interest, providing expertise in systems engineering, information technology, operational concepts, and enterprise modernization for Federally Funded Research and Development Centers (FFRDCs) including the department of Defense, the Federal Aviation Administration, the Internal Revenue Service and U.S. Department of Veterans Affairs and the Department of Homeland Security [MITRE]. MITRE put forward a ROI analysis method consisting of a Quantitative analysis which elicits traditional financial measures like Net Present Value (NPV), Benefit Cost Ratio, Internal Rate of Return (IRR) and Discounted Payback Period as well as a Qualitative analysis which is assessed by discussion priorities and strategic direction, listing of strengths and weaknesses and by eliciting expert judgment [Buck 08]. Figure 4-1 shows this difference between a ROI calculation and a ROI analysis.

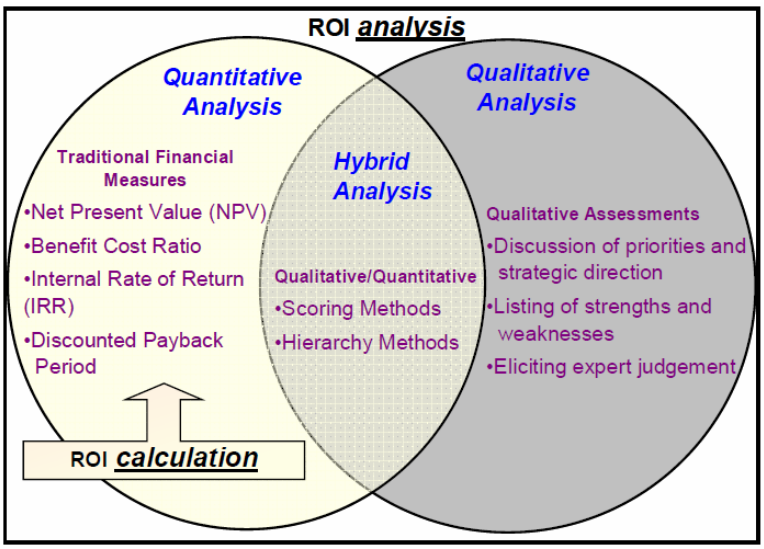

Figure 4-1: MITRE ROI Calculation versus ROI Analysis

ROI analysis is more suitable for Government organizations because it often involves qualitative measures which cannot easily be monetized, like social implications or adoption of a new technology. MITRE considers five qualitative measures within their ROI analysis approach.

- What are the social consequences?
- What are the strategic implications?
- What is the effect on employee morale?
- What are the political ramifications?
- Stoplight matrix of risk assessment

Figure 4-2 shows where these qualitative measures fit in their ROI analysis approach.

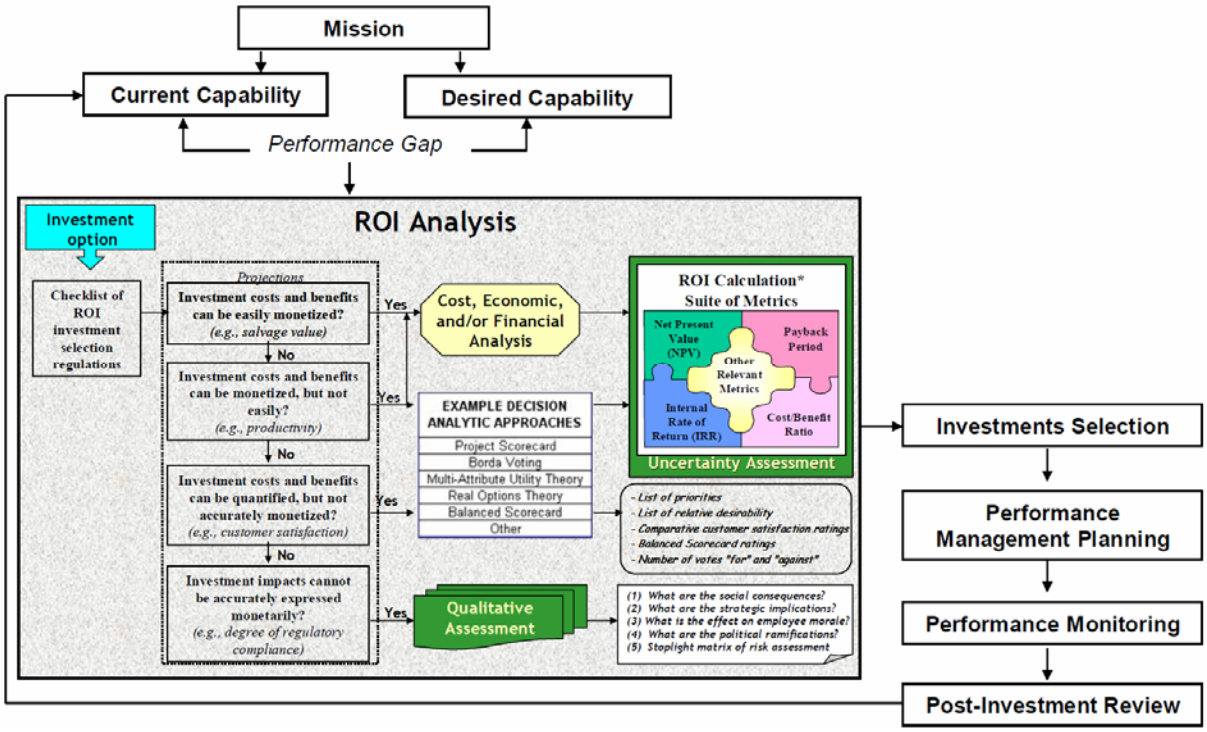

Figure 4-2: MITRE ROI Analysis

Explanation of ROI calculation Suite of Metrics from figure 4-2:
∗ **Net Present Value (NPV)** is the base year value of all current and future net expected benefits.
∗ **Internal Rate of Return (IRR)** describes that particular discount rate at which current and future cash inflows equal cash outflows.
∗ **Discounted Payback Period (DPP)** equals the number of periods it takes discounted cost savings or other benefits to just equal the initial (discounted) investment amount.
∗ **Benefit / Cost Ratio (BCR)** is the sum of the expected benefits divided by the discounted value of expected cost component. [Buck 08]

4.3 Quantitative SOA measures

Quantitative SOA measures are related to reductions in costs, both during implementation and operation. This chapter provides some methods and example calculations that, to the best of our knowledge, form an accurate representation of what can be expected in practice.

4.3.1 Improved efficiency trough reuse

To analyze the possibilities for reuse it is necessary to define what constitutes a reusable asset and how to calculate its estimated value. Oracle in its Practitioners Guide differentiates between three types of reusable assets: Services, Black-box code assets and White-box code assets.

Services have higher production and overheads costs as they require generalized requirements and a broad scope of tests. They are typically deployed once and then used by multiple users. Black-box code refers to implementations that are incorporated in a code base and are hidden from the end-user. Production costs and overhead are similar to those of services while additional costs are incurred because of necessity to test and maintain multiple deployed instances. White-box code refers to implementations that are visible and modifiable by end-users. They have lower production costs but carry higher maintenance costs as different variances of deployed instances need to be tested and maintained.

To produce reusable assets additional investments are required as opposed to producing assets intended for single use.

Services	200%
Black-box Assets	200%
White-Box Code Assets	100% - 200%

Reusing assets is also not free, a consumption factor is applied to account for evaluating and reusing an asset.

Services	5%
Black-box Assets	20%
White-box code Assets	40% (< 25% code modifications)
White-box code Assets	90% (> 25% code modifications)

This shows that while producing reusable assets requires up to twice the investment needed for assets intended for single use, the cost for reusing a Service is a mere 5 percent of the cost of developing a Service from scratch. Reusing Black-box assets is rated at 20 percent or four times more expensive than Services. When possibilities exists for multiple reuse the cost of reuse becomes the determining factor for efficiency improvement. [Bennett 09]

4.4 Qualitative SOA measures

Qualitative SOA measures follow from the social and strategic implications of the SOA implementation. Extensive research has been performed in this area and objectives have been set out by the Dutch government. These objectives are documented as NORA principles. The next section will condense the general NORA principles into e-Government specific objectives which can later be applied to the SAS-LEG research.

The NORA principles can be separated into three groups:

I. Principles that only describe basic demands to the ICT infrastructure, nothing specific to SOA.
II. Principles that could be implemented or achieve increased efficiency by using a SOA but do not describe the SOA itself.
III. Principles that specifically focus on the implementation of a SOA.

The details of the first two group are not relevant in this context. The main focus will be on the principles of the third group, since this is where the qualitative measures for SOA implementations are defined. This section will start by selecting the relevant main principles of NORA and then continue with the derived principles that follow from this.

4.4.1 NORA principles focused on SOA implementations

P4. One stop shopping

Organizations in the public domain preferably offer their services (products) in logical bundles for the customer, per (type of) event at the customers side (birth, marriage, starting company) and work together with other organizations in the public domain towards achieving this goal ("one stop shopping").

P16. Point to relevant services

Organizations in the public domain point citizens and companies to services relevant for them (proactive service provisioning), but also allow for own orchestration and responsibilities by citizens and companies when it comes to the actual use of NORA services. While doing so, organizations provide understandable information, preferably per individual case, on rights, duties and possibilities for citizens and companies.

P17. Consistent and reliable government

Organizations in the public domain organize themselves as part of an integral operating government which acts in unison and when acting towards citizens, companies and civilian institutions is consistent and reliable.

P19. Use of generic building blocks

Use where possible generic building blocks. Organizations in the public domain aim to use available public services whenever these, when it comes to functionality, security and costs, are equal to individual services.

P20. Standardize and optimalize

Standardize and optimalize internal operations

4.4.2 Selection of derived principles focused on SOA implementations

The NORA principles contain multiple derived principles; these can again be divided in the same three categories as the main principles. This section takes the principals that are specifically focused on SOA implementations and divides them according to their relevance for SOA implementations into Business, Information and Technical requirements.

4.4.2.1 Business Requirements

5.1.5. **P4. P17. Government organisations work together on services for citizens and businesses using a Service Oriented Architecture.**

This objective follows from one of the core objectives of the Dutch government to organize the IT infrastructure as a Service Oriented Architecture. There is a strong correlation between the specification of the “Service Gerichte Architectuur” as specified by NORA and the attributes of a SOA approach.

Qualitative measures:

- ☐ Support of Dutch e-Government SGA principles

5.2.2.3. **P4. P17. Government organisations make agreements regarding delivery of services.**

Complex laws with many exceptions mean that agreements regarding specific services are bound to be very specific and elaborate in nature. Implementing these agreements requires an investment in the same order of magnitude as producing the specification for it would. Making these implementations available as services on a national level will significantly reduce the investments individual municipalities need to make. A SOA approach is specifically aimed towards this goal.

Qualitative measures:

- ☐ Infrastructure support for developing and sharing services
- ☐ Establishing and adhering to global quality attributes by government organizations

5.2.1.13. **P16. Organizations in the public domain direct citizens and businesses to services which are relevant to them (proactive servicing).**

In order to direct citizens and businesses to services that are relevant to them, the organisation needs to link the personal/ business situation of each subject to the specific requirements that exist for each service. The comparison of such large amounts of data requires a high degree of automation to be efficient. Before this can happen it is necessary to make all information available within the same infrastructure. Given the current IT landscape of many different systems, a Service Oriented Architecture implementation is the most efficient approach towards achieving this.

Qualitative measures:

- ☐ Infrastructure support for sharing services
- ☐ Support for automating discovery and selection of relevant services
- ☐ BPM support to orchestrate services

5.1.4. **P17. The architecture approach of government organizations is aimed at delivering services to citizens and businesses through multiple channels, as well as on mutual cooperation by combining service processes and sharing data.**

In order to efficiently offer services trough multiple channels it is necessary to separate the different communication channels from the actual execution of the process. This can be achieved by implementing a front-end and a back-end linked together by middleware. This is exactly what is achieved by implementing a SOA as combining service processes en sharing data is one of the key characteristics of a SOA. Various services to citizens and business require different combinations and adaptations to electronic services. In order to streamline this process there is a need for systematic Variability Management.

Qualitative measures:

- ☐ Support of Dutch e-Government SGA principles
- ☐ Uniform interfaces to enable cooperation between back-office services and front-end communication channels
- ☐ Efficient customization of processes to fit needs of varying citizens and businesses
- ☐ Efficient discovery and selection of relevant services
- ☐ Support for efficient and flexible configuration of service processes

5.2.1.7. / 5.2.2.1. **P17. P4. P20. Services (both human and electronic) can be composed from other services.**

Service Composition is a typical attribute of the Service Oriented Architecture approach and the demand for composing electronic services is therefore easily fulfilled. However, the demand to compose human/government services requires some more consideration. As these services are most likely executed by different people in different situations, the focus is on communication and clear separation of responsibilities. The most efficient way is to split the service process up into smaller tasks that have clearly defined inputs and outputs, and then combine these until the entire service process is complete. This creates a system that is very flexible to changing needs, as individual services can be combined in a different way, instead of completely overhauling the entire service process. Every link in the chain has clear responsibilities as dictated by the required inputs and outputs, and every step of the process is clearly defined and visible. This results in clear communication and an overall efficient process. A Service Oriented Approach is especially suitable for implementing the service process in such a manner, as the human services and electronic services can mapped precisely on top of each other. Given the large number of different service processes that may occur, additional consideration is required to efficiently manage this process. In order to combine the services into different processes an efficient system of Variability Management is required.

Qualitative measures:

- ☐ Support of Dutch e-Government SGA principles
- ☐ Business Process Modelling support to orchestrate human services
- ☐ Efficient discovery and selection of relevant services
- ☐ Maintaining global quality attributes when composing human and electronic services

5.2.2.4. **P17. The demands that are placed upon human services, like quality, measurability and costs, also apply for electronic services.**

In order to guarantee that both human and electronic services meet designated demands, a system for quality assurance is required. To eliminate redundant work, the same quality assurance process should be used for both human and electronic services. Measuring individual service quality and costs requires that each service is clearly defined by responsibilities and required inputs and outputs. Also it needs to be transparent how and where services are connected to each other, so this needs to be done in a systematic way. A Service Oriented Architecture approach is the most logical way to achieve these goals. When changing environments like a changed law or new exception requires an existing service to be changed, the quality attributes that are measured/checked need to be updated to the new situation as well. To streamline this process it is necessary to focus on a systematic approach to Variability Management, so that not only services can be changed efficiently to fit specific goals but also their related quality assurance process is systematically updated in the same process.

Qualitative measures:

- ☐ System for maintaining global quality attributes both for human and electronic services

5.3.1. **P17. Services trigger each other and as such can be used to connect processes together.**

When services can trigger each other it is of critical importance that all services are separate entities with clearly defined responsibilities and inputs and outputs. This allows services to be changed or swapped out without breaking the entire chain of the service process. To increase efficiency the approach requires a degree of flexibility, which allows services to be selected trough some sort of discovery register, based on their defined inputs and outputs as well as their quality attributes. This approach is part of a systematic approach to Variability Management that is required for an overall efficient process of constructing, executing and measuring of multiple services processes. A SOA is the embodiment of just such a process.

Qualitative measures:

- ☐ Support of Dutch e-Government SGA principles
- ☐ Efficient discovery and selection of relevant services

4.4.2.2 Information Requirements

6.1.2.1. **P19. P20. Service channels are connected to the generic building blocks of the e-government wherever possible.**

To connect service channels to existing generic building blocks, these building blocks need to be offered as services clearly defined by way of required inputs and outputs, responsibilities and quality attributes. To connect to these services it is necessary to first locate them trough a form of service discovery register which lists their specifications. Secondly these building blocks need to be connected to construct service processes. Given the large number of possible variations of service processes, it is necessary to have a systematic approach to Variability Management in order to achieve high efficiency and constant quality assurance.

Qualitative measures:

- ☐ Efficient discovery and selection of relevant services
- ☐ Efficient customization of processes to fit needs of varying citizens and businesses

6.1.1.1. **P20. The execution of processes is done with maximum use of ICT.**

To make maximum use of ICT it is necessary to reduce the amount of time spend by people on processes. Both on executing the daily processes as well as designing/composing the service processes themselves. Basic services should be implemented only once and then be made available to all other service processes. Service processes should be composed only once and then be easily changed, duplicated or updated. Composition of these service processes should follow directly from their service description with the appropriate quality attributes. Services therefore have to be placed in a discovery registry that transparently describes all the required inputs, outputs and responsibilities, as well as their quality attributes. This makes it possible to easily implement services directly from their description and than compose these services into service processes. Systematic Variability Management then makes it possible to efficiently change, duplicate or update these processes in order to fit the needs of the various business cases.

Qualitative measures:

- ☐ Efficient discovery and selection of relevant services
- ☐ Support for flexible configuration of service processes
- ☐ Implementations follow from business level descriptions

6.1.1.3. **P20. Organizations and applications which operate in different functional domains co-operate using services.**

The demand for cooperation using services requires an architecture which supports this, i.e. a Service Oriented Architecture approach. Implementing this means that all activities are modelled as services

and, as the communication channels already exist, these services can be made available to organizations and applications in other functional domains. The specific services aimed at cooperation between different functional domains have to be listed in a registry; the same registry can be used to make all other services available to the entire infrastructure. This means a single Service Oriented Architecture and discovery registry fulfil the e-government demand and lead to increased efficiency within all the functional domains.

Qualitative measures:

- ☐ Support of Dutch e-Government SGA principles
- ☐ Efficient discovery and selection of relevant services
- ☐ Support for defining global quality attributes
- ☐ Business Process Modelling support to efficiently orchestrate services from different functional domains

6.1.1.6. **P20. The management of business processes is done by deploying Business Process Management systems.**

Making the service processes available for use with BPM systems requires services to adhere to certain specifications, which define inputs, outputs, responsibilities and quality attributes. BPM systems can not only be used to execute service processes but also aid in the efficient composition of new or changed processes by allowing the use of a systematic approach towards Variability Management. When part of a process involves manual tasks, the relevant process needs to be supported by a Workflow Management System.

Qualitative measures:

- ☐ Architecture supports deployment of BPM systems
- ☐ Efficient customization of processes

6.1.1.8. **P20. Applications make use of the standard facilities of their environment.**

In order to use standard facilities, these facilities need to have clearly defined inputs, outputs, responsibilities and quality attributes. This requires a system of offering services within a Service Oriented Architecture. By using a transparent and systematic discovery registry, as many services as possible can be made available within the infrastructure, thus achieving increased efficiency.

Qualitative measures:

- ☐ Efficient discovery and selection of relevant services

6.1.3.1. **P20. The logical connection of organizations to sectoral busses is done by Business Process Management solutions.**

The use of Business Process Management solutions requires services with clearly defined inputs, outputs, responsibilities and quality attributes. This makes it possible to make services available throughout the infrastructure and the BPM environment then allows the efficient connection of organizations to sectoral busses.

Qualitative measures:

- ☐ Architecture supports deployment of BPM systems
- ☐ Efficient discovery and selection of relevant services

4.4.2.3 Technical Requirements

7.1.1. **P20. While considering the importance of availability, interoperability and security, government organizations are relatively free in choosing technical components.**

The combination of different technical components combined with a demand for interoperability quickly leads to a structure which is based on services, where different technical components can exist because they fulfil the specifications of the service they are providing in terms of required inputs, outputs, responsibilities and quality attributes. Architecture supporting this structure has to be a Service Oriented Architecture. Because implementation does not matter as long as the demands for the service are met, implemented services can be made available throughout the infrastructure by placing them in a central registry.

Qualitative measures:

- ☐ Architecture supports deployment of BPM systems
- ☐ Efficient discovery and selection of relevant services
- ☐ Support for defining global quality attributes
- ☐ Support of Dutch e-Government SGA principles
- ☐ Efficient customization of processes

4.4.3 Qualitative Measures overview

These qualitative measures can be condensed by removing the redundant measures from different principles. Further investigations shows that the measures can be divided into five distinct groups, namely Qualitative Measures relating to:

- SOA requirements
- Discovery and selection of services
- Quality attributes
- Support for BPM solutions
- Variability management

Table 4-1 shows an overview of all qualitative measures from the derived NORA principles divided into the five main groups detailed above. The columns represent each of the NORA principles ordered by their NORA internal reference number. The rows list the qualitative measures for each of the five groups.

	5.1.5. **P4. P17.**	5.2.2.3. **P4. P17.**	5.2.1.13. **P16.**	5.1.4. **P17.**	5.2.1.7. / 5.2.2.1.	5.2.2.4. **P17.**	5.3.1. **P17.**	6.1.2.1. **P19. P20.**	6.1.1.1. **P20.**	6.1.1.3. **P20.**	6.1.1.6. **P20.**	6.1.1.8. **P20.**	6.1.3.1. **P20.**	7.1.1. **P20.**
Qualitative measures relating to SOA requirements														
Support of Dutch e-Government SGA principles	x			x	x		x			x				x
Qualitative measures relating to discovery and selection of services														
Infrastructure support for developing and sharing services		x	x											
Efficient discovery and selection of relevant services			x		x		x	x	x	x		x	x	x
Qualitative measures relating to quality attributes														
Establishing and adhering to global quality attributes by government organizations		x												
Maintaining global quality attributes when composing human and electronic services					x	x				x				x
Qualitative measures relating to support for BPM solutions														
Support for efficient and flexible BPM solutions			x					x						
Uniform interfaces to enable cooperation between back-office services and front-end communication channels				x										
Business Process Modelling support to orchestrate human services					x									
Implementations follow from business level descriptions									x					
Architecture supports deployment of BPM systems											x		x	x
Business Process Modelling support to efficiently orchestrate services from different functional domains										x				
Qualitative measures relating to variability m**anagement**														
Efficient customization of processes to fit needs of varying citizens and businesses				x				x	x		x			x

Table 4-1: Qualitative measures from NORA principles

Analysis of this table shows some requirements to be shared by almost all NORA principles. A closer look reveals that these requirements originate from demands placed upon large and diverse

organizations like the Dutch e-Government. The need for efficient discovery and selection of service is one the consequences, as is the need for efficient customization of processes.

4.5 Summary

When evaluating measures for e-Government it is important to differentiate between quantitative and qualitative measures. While commercial enterprises will focus mostly on cost-saving factors, government organizations also have to consider social aspects of their strategy.

Quantitative measures for SOA implementations are connected to the potential for reuse. This chapter has shown the investments and returns that can be expected from a service implementation rather than using Black box or White box code implementations. Although developing reusable assets requires additional investment this is quickly outweighed by the returns when the potential for reuse is high. Successfully enabling reuse for municipalities with the SAS-LEG projects will result in greatly improved efficiency for local e-Governments.

Qualitative measures for the Dutch local e-Government can be extracted from the Dutch Government Reference Architecture (NORA) and this study has shown that five NORA principles aimed at SOA deliver a total of 14 derived key principles that specifically focus on the implementation of a SOA, covering the areas of Business, Information and Technical architecture requirements. This set of fourteen derived principles delivers the Qualitative Measures for SOA implementations for local e-Governments. Achieving these requirements with the SAS-LEG project means achieving the objectives for efficiency improvement of the Dutch government.

5 How does the SAS-LEG project demonstrate increased efficiency for local e-governments?

5.1 Introduction

This chapter describes the SAS-LEG Project and introduces the tools, activities and attributes that take place at the Business, Architecture and Services level, as well as the global attributes of the SAS approach and shows how these can be used to achieve the qualitative and qualitative measures discovered during the literature study of the previous chapter. Analysis of the qualitative measures for efficiency improvement showed the are divided over five major groups, which will each be discussed independently in this chapter.

5.2 Meeting quantitative measures

The analysis from the previous chapter showed that producing reusable assets requires up to twice the investment needed for assets intended for single use, but the cost for reusing a Service is a mere five percent of the cost of developing a Service from scratch [Bennett 09]. When possibilities exists for multiple reuse the cost of reuse becomes the determining factor for efficiency improvement. Chapter two showed the Netherlands consisted of 430 municipalities are implementing the same laws at the local level, creating a huge potential for reuse. It is clear from this analysis successfully reusing services by municipalities will lead to significantly improved efficiency.

5.3 Meeting qualitative measures

The analysis of qualitative measures for improved efficiency for local e-Government showed a strong dependency on support of SGA principles, efficient variability management, global quality attributes, efficient discovery and selection of services and support for BPM solutions. This chapter has shown that the SAS-LEG project is spearheading research into these areas. The next section will provide a more detailed insight into how these qualitative measures can be demonstrated. Each section discusses one of the five groups and is directly applied to the qualitative measures defined in the previous chapter and, if applicable, checked by a tick-box ☑.

5.3.1 Qualitative measures relating to SGA requirements

The following NORA principles provide a demand for adhering to SGA principles.

	5.1.5. **P4. P17.**	5.2.2.3. **P4. P17.**	5.2.1.13. **P16.**	5.1.4. **P17.**	5.2.1.7. / 5.2.2.1.	5.2.2.4. **P17.**	5.3.1. **P17.**	6.1.2.1. **P19. P20.**	6.1.1.1. **P20.**	6.1.1.3. **P20.**	6.1.1.6. **P20.**	6.1.1.8. **P20.**	6.1.3.1. **P20.**	7.1.1. **P20.**
Qualitative measures relating to SGA requirements														
Support of Dutch e-Government SGA principles	x			x	x		x			x				x

Table 5-1: Qualitative measures relating to SGA requirements

The NORA analysis in chapter 3 provided an overview of the five main principles of the Dutch SGA approach:

- Transparent responsibilities, open architectures
- Outside-in Design
- Disconnection
- Reusability
- Situational and context independence

These principles are centred around the concept of services within a SOA architecture, dictating the use of independent services, clear interfaces separated from implementations, possibilities for reuse, composition and use of open standards. These requirements are met by standard SOA principles on which the SAS-LEG project is building and require no additional research to be enabled. They only indicate the constraints to which a SAS approach has to adhere, since the SAS-LEG project expands on the advantages provided by each of these principles, it is possible to conclude that these qualitative measure is achieved.

☑ Support of Dutch e-Government SGA principles

5.3.2 Qualitative measures relating to discovery and selection of services

Nearly all NORA principles dealing with SOA requirements depend on an efficient system for the discovery and selection of services. This is a natural consequence of the large size of the e-Government system and related government organizations. Another driving factor is the large number of different services or variants that has to be offered to fit the various needs of individual citizens and businesses.

	5.1.5. **P4. P17.**	5.2.2.3. **P4. P17.**	5.2.1.13. **P16.**	5.1.4. **P17.**	5.2.1.7. / 5.2.2.1.	5.2.2.4. **P17.**	5.3.1. **P17.**	6.1.2.1. **P19. P20.**	6.1.1.1. **P20.**	6.1.1.3. **P20.**	6.1.1.6. **P20.**	6.1.1.8. **P20.**	6.1.3.1. **P20.**	7.1.1. **P20.**
Qualitative measures relating to discovery and selection of services														
Infrastructure support for developing and sharing services		x	x											
Efficient discovery and selection of relevant services			x		x		x	x	x	x		x	x	x

Table 5-2: Qualitative measures relating to discovery and selection of services

The SAS-LEG aims to research techniques to automate the process of service discovery with the desire to keep the business domain as generic as possible. Automatic composition of web services can be achieved by modelling the problem as a CSP (Constraint Satisfaction Problem). Web services are then automatically composed on demand according to the preferences of the user. The planning

problem is represented in the form of constraints, as applied by [van Beek 99] which maintains the structure of the high-level domain description. Accommodation for incomplete knowledge is provided by support for pro-active information gathering. The contribution of a rich goal language allows for extended goals beyond the final state, undesirable situations are avoided favouring sensing, non-committing actions first [Kaldeli 09]. This fits the requirements from the NORA principles for the efficient discovery and selection of relevant services.

☑ Infrastructure support for developing and sharing services

☑ Efficient discovery and selection of relevant services

5.3.3 Qualitative measures relating to quality attributes

Global quality attributes play a major role in the system of e-Government pursued by the Dutch government. The nature of e-Government creates a strong demand for processes that deliver services to citizens that adhere to a consistent and high level quality. Every step of the process needs to meets this requirement in order to guarantee that every citizen get the quality of service he is legally entitled to from the government.

	5.1.5. **P4. P17.**	5.2.2.3. **P4. P17.**	5.2.1.13. **P16.**	5.1.4. **P17.**	5.2.1.7. / 5.2.2.1.	5.2.2.4. **P17.**	5.3.1. **P17.**	6.1.2.1. **P19. P20.**	6.1.1.1. **P20.**	6.1.1.3. **P20.**	6.1.1.6. **P20.**	6.1.1.8. **P20.**	6.1.3.1. **P20.**	7.1.1. **P20.**
Qualitative measures relating to quality attributes														
Establishing and adhering to global quality attributes by government organizations		x												
Maintaining global quality attributes when composing human and electronic services					x	x				x				x

Table 5-3: Qualitative measures relating to quality attributes

The research into the most suitable ADL is extended with research towards the most suitable architecting method, with the objective that quality attributes drive the architecture. Architecting processes being considered are the Attribute-Driven-Design (ADD) method, the QASAR method and the BAPO/CAFCR approach. Further consideration will be given to the Bachman reasoning framework and RUP process which places architectural significant non-functional requirements in the centre of the process.

It is clear from the analysis of the SAS-LEG project that not only do quality attributes play a major factor in design process, but the design process is centred around it. Research into Quality Driven Architecting methods is aimed at pursuing a streamlined process from business level demand to

service level implementation of processes based on their quality requirements. The composition of human and electronic services is driven by the quality requirements directly from the business layer.

☑ Establishing and adhering to global quality attributes by government organizations

☑ Maintaining global quality attributes when composing human and electronic services

5.3.4 Qualitative measures relating to support for BPM solutions

The drive towards a Service Oriented Architecture for the e-Government environment is accompanied by a necessity to manage this nation wide organization serving millions of citizens, each with their individual personal situations. This is represented by the large number of NORA principles that place demands on the systematic management of business processes.

	5.1.5. **P4. P17.**	5.2.2.3. **P4. P17.**	5.2.1.13. **P16.**	5.1.4. **P17.**	5.2.1.7. / 5.2.2.1.	5.2.2.4. **P17.**	5.3.1. **P17.**	6.1.2.1. **P19. P20.**	6.1.1.1. **P20.**	6.1.1.3. **P20.**	6.1.1.6. **P20.**	6.1.1.8. **P20.**	6.1.3.1. **P20.**	7.1.1. **P20.**
Qualitative measures relating to support for BPM solutions														
Support for efficient and flexible BPM solutions			x					x						
Uniform interfaces to enable cooperation between back-office services and front-end communication channels				x										
Business Process Modelling support to orchestrate human services					x									
Implementations follow from business level descriptions									x					
Architecture supports deployment of BPM systems											x		x	x
Business Process Modelling support to efficiently orchestrate services from different functional domains										x				

Table 5-4: Qualitative measures relating to support for BPM solutions

The SAS-LEG project places a strong focus on the use of BPM systems. This starts with researching the most suitable Business Modelling Language to support such a system. This includes determining the suitability of the RUP business modelling workflow, use of UML profiles, the OMG Business Process Modelling Notation as well as the use of commercial tools like SAP, BAAN, Oracle and PeopleSoft. Cordys is a technology partner developing a prototype for the next-gen BPM platforms.

Following research into business modelling language, the SAS-LEG continues with research into the most suitable Architecture Description Language for local e-Government systems. After researching suitable languages at the business and architecture levels, the SAS-LEG continues with research into

the most suitable language at the service level, like the Business Process Execution Language (BPEL) or Business Process Modelling Notation (BPMN).

The SAS-LEG project pursues the concept of Model Driven Engineering with the aim of streamlining the development process from business demands trough architecture trough services. Architectural and service implementations can be constructed from requirements at the business level without a need for developing new specifications.

In the context of BPM, variability indicates that parts of a business process remain variable, or not fully defined, in order to support different versions of the same process depending on the intended use or execution context. The SAS-LEG project aims to define and classify a fundamental set of requirements of systems for explicit variability management in BPM solutions. Review of existing frameworks towards this end has showed that none of these address all or even most of these requirements [Aiello 10].

The SAS-LEG project spearheads significant developments in linking Business Process Management solutions to Service Oriented Architectures. Business Modelling language is linked to Architecture Description Language and subsequently Business Process Execution Language to provide seamless development of business processes, from business process requirements to service implementation across all functional domains of the e-Government environment. Quality Driven Architecting and global quality attributes enable the development of service processes to fit the needs of the business requirements, which can be modelled from a BPM environment.

- ☑ Support for efficient and flexible BPM solutions
- ☑ Uniform interfaces to enable cooperation between back-office services and front-end communication channels
- ☑ Business Process Modelling support to orchestrate human services
- ☑ Implementations follow from business level descriptions
- ☑ Architecture supports deployment of BPM systems
- ☑ Business Process Modelling support to efficiently orchestrate services from different functional domains

5.3.5 Qualitative measures relating to variability management

Support for variability management is closely linked to the support for BPM systems, since BPM solutions in such a diverse environment as the Dutch e-Government cannot be successful without the means to adapt service processes to fit the need of individual citizens and companies. Accordingly many NORA principles place demands on the support of variability management within the e-Government infrastructure.

	5.1.5. **P4. P17.**	5.2.2.3. **P4. P17.**	5.2.1.13. **P16.**	5.1.4. **P17.**	5.2.1.7. / 5.2.2.1.	5.2.2.4. **P17.**	5.3.1. **P17.**	6.1.2.1. **P19. P20.**	6.1.1.1. **P20.**	6.1.1.3. **P20.**	6.1.1.6. **P20.**	6.1.1.8. **P20.**	6.1.3.1. **P20.**	7.1.1. **P20.**
Qualitative measures relating to variability m**anagement**														
Efficient customization of processes to fit needs of varying citizens and businesses				x				x	x		x			x

Table 5-5: Qualitative measures relating to variability management

Variability is the ability of a software system or artefact to be extended, changed, customized, or configured for use in a specific context. [Sinnema 06] Two important concepts related to variability are variation points and variants. Variation points are locations in the design or implementation at which variation will occur, and variants are the alternatives that can be selected at those variation points [Bachmann 01].

A distinction can be made between design-time and run-time variability, differing in both characteristics and utilization of techniques. Variability management is inherently linked to Business Process Management as the need for variability (whether at design-time or run-time) follows from changing business demands or business processes.

The COVAMOF framework was developed at the University of Groningen to support variability management of software product families and supports the automatic run-time modelling of variability via UML diagrams. [Sinnema 04] A newly developed language VxBPEL was developed to enable variability in BPEL by introducing extra XML elements to support variation points and variants in a BPEL process. [Koning 09] The SAS-LEG research has resulted in the definition of a UML profile has been to model variability in the architecture of Web service-based systems. This development supports run-time variability management whereby all variability information is stored in a Variation point Interaction Diagram (VID) [Sun 10].

Service Oriented Architectures facilitate the task of adapting business processes to different execution environments and organizational needs by exposing the functionalities needed by the process in an abstract way, decoupled from the implementation. Designing a general framework to manage reference processes and guide their customization in regulated environments can lead to great deal of reuse and efficiencies. The SAS-LEG project proposes an approach for controllable process customization where process deployment is additionally controlled and guided by constraints and guidelines created during process design, allowing for a more stable and safe process customization, thus simplifying process reuse and maintenance [Bulanov 09].

Closely linked to the support of BPM solutions, variability management is one of the key research areas the SAS-LEG project is spearheading. Research is not just limited to the frameworks for service representation and discovery registers but is taken a step further by supporting the automatic run-time modelling of variability by business processes. This creates the possibility for run-time process customization based on business constraints without the need for human interference, leading to greatly increased efficiency.

☑ Efficient customization of processes to fit needs of varying citizens and businesses

5.4 Summary

This chapter has provided a detailed description of the SAS paradigm and its attributes, as well as the tools and activities take it contains. These attributes have been connected to the quantitative and qualitative measures which were discovered during the literature study. Primary success factors that were determined in this study included the approach to variability management, the use of BPM systems, efficient discovery and selection of services and support for global quality attributes. This chapter has shown the SAS-LEG project is spearheading development in these key areas, meeting the quality measures stemming from the NORA principles.

6 Conclusion

The Dutch government has initiated increasingly ambitious e-Government initiatives over the years and is currently and is currently pursuing a Service Oriented Architecture approach as defined in the Dutch government reference architecture. Simultaneously there is a political movement to transfer responsibilities from the national government to municipalities. This means that 430 municipalities must implement and support the same laws at the local level, creating a large potential for redundancy.

The SAS-LEG project proposes to use the Software as Service (SaS) principle to implement a law once and offer it as a customizable service to several municipalities. Achieving increased efficiency is enabled by the use of a service oriented architecture supplemented by new research into tools and techniques aimed at the e-Government environment. This raises the question of how increased efficiency for local e-governments can be demonstrated.

To answer that question, the main research question of this thesis has been formulated as:

> "How can the SAS-LEG project, which allows municipalities to implement national laws in a local context, be used to demonstrate that using the Software as Service (SAS) paradigm leads to increased efficiency for local e-governments?"

To answer this question, the following sub-questions need to be answered:

- What is the current status of local e-Government in the Netherlands?
- How does the Service Oriented Architecture approach fit into local e-Government?
- How can improved efficiency in local e-Government be measured?
- How does the SAS-LEG project demonstrate increased efficiency for local e-governments?

The results of each of these sub-questions will be detailed in the next sections.

6.1 Current status of local e-Government in the Netherlands

Chapter 2 provided an overview of local e-Government in the Netherlands, it showed a history of e-Government initiatives dating back to 1994, with NUP starting in 2008. All this work has culminated into the creation of NORA, the Dutch Government Reference Architecture, containing the results of all previous programmes. A specific reference architecture for local governments (GEMMA) is available which adheres to NORA and adds municipality specific support. NORA in turn adheres to international open standards and the European Interoperability Framework.

6.2 Service Oriented Architecture approach and local e-Government

Chapter 3 showed that the Dutch government is actively pursuing a Service Oriented Architecture approach. The 'Service Gerichte Architectuur' (SGA) contains five principle SOA objectives and four main elements a SOA should adhere to.

6.3 Measures for improved efficiency in local e-Governments

There is a fundamental difference between government organizations and commercial enterprises when it comes to determining increased efficiency or Return On Investment. Enterprises will focus primarily on monetary returns whereas government organizations also need to consider social implications.

The main quantitative measure for increased efficiency lies within the concept of reuse. Experiences from practice show that although developing services for reuse is up to twice as expensive as developing for single use, the cost of reuse is only 5%. When there is potential for multiple reuse, as there is with hundreds of municipalities, this reuse cost becomes the determining factor.

Qualitative measures follow from the objectives defined by NORA, five main principles and fourteen derived principles are specifically aimed at SOA implementations. Analysis of these principles shows a division into five main groups: SOA requirements, Discovery and selection of services, Quality attributes, Support for BPM solutions and Variability management.

6.4 Demonstrating increased efficiency for local e-governments

The SAS-LEG is focusing research in different areas at the business, architecture and service level, as well as at the global level. Emphasis is placed on providing variation points at all three levels in combination with support for BPM systems to support both design-time and run-time configuration. Global quality attributes enable quality driven architecting methods and Quality of Service agreements at the service level. The step-by-step analysis of qualitative measures stemming from the NORA principles demonstrated that the SAS-LEG is spearheading research in every major subject area necessary for the implementation of SOA-based e-Government solution as envisioned by the Dutch government.

6.5 Summary

By answering the list of sub questions above, this thesis has provided an overview of the status of local e-Government in the Netherlands and showed how the SOA approach fits into the Dutch e-Government approach. This thesis subsequently defined a list of quantitative and qualitative measures to determine increased efficiency for local e-Governments and subsequently matched these to the research areas the SAS-LEG is spearheading. By doing so, the increased efficiency offered by the SAS-LEG project to local e-Governments has been demonstrated and the main research question has been answered.

6.6 Discussion

Implementing a Service Oriented Architecture is a major goal of the Dutch e-Government approach and NORA has been tailored towards this objective. It is clear from the analysis in this thesis that the research performed during the SAS-LEG project not only achieves the goals put forward by NORA, but exceeds these goals in several areas. For example NORA requires the presence of a service registry and the SAS-LEG project takes this a step further and provides automated service discovery by modelling the intended service as a Constraint Satisfaction Problem. The offering of automatic run-time configuration goes well beyond the NORA goal of merely supporting the customization of processes.

To enable a successful implementation of software as a service for local e-Governments, a number of enabling factors are required at government level. First, the laws defined at the national level need to suitable to be offered as customizable services. Input from municipality experts suggest that national laws have a high level of abstraction and leave a significant part of the process to be defined by municipalities. It may therefore prove difficult to offer customizable processes at a national level, when the process itself has yet to be defined at the municipality level. In order for the SAS-LEG paradigm to enable significant reuse it might be necessary to alter the government process towards providing more and stricter constraints at the national level.

6.7 Future work

The increased efficiency of the SAS-LEG project has been measured based on goals and objectives put forward by the Dutch government in its reference architecture. An important step which remains is measuring the increased efficiency achieved in practice. Future work therefore includes an extensive evaluation with users to determine the actual achievements.

Another area of future research lies in the gap between the relative high level NORA requirements for successful implementation and the local requirements of the various municipalities for the actual implementation. An analysis is required of municipalities across the board to determine potential problems and opportunities for different types of municipalities in order to develop the most effective implementation strategy.

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