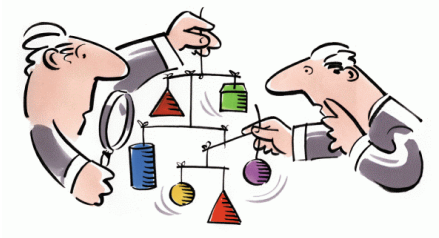
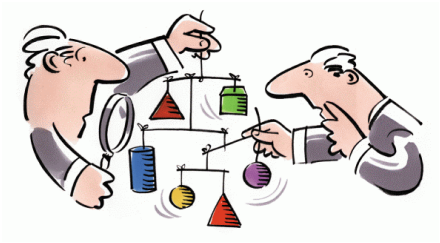


Viewpoints Functionality and Examples

ArchiMate D3.4.1a v2.6



Colophon

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Company :	Telematica Instituut
Authors :	Hugo ter Doest, Maria-Eugenia Iacob, Marc Lankhorst, Diederik van Leeuwen, Robert Slagter

Synopsis:

This report introduces a classification framework for viewpoints, which entails three types of viewpoints, grouped according to their purpose: (1) designing, (2) deciding, and (3) informing. Of each viewpoint a number of example views is given and it is shown how these views can be derived from ArchiMate models using selection and abstraction rules.

ArchiMate

Organisations need to adapt increasingly quickly and anticipate changing customer requirements and business goals. This need influences the entire chain of activities of a business, from the organisational structure to the network infrastructure. How can you control the impact of these changes? Architecture may be the answer. The ArchiMate project will develop an integrated architectural approach that describes and visualises the different business domains and their relations. Using these integrated architectures aids stakeholders in assessing the impact of design choices and changes.

Architecture is a consistent whole of principles, methods and models that are used in the design and realisation of organisational structure, business processes, information systems, and infrastructure. However, these domains often are not approached in an integrated way, which makes it difficult to judge the effects of proposed changes. Every domain speaks its own language, draws its own models, and uses its own techniques and tools. Communication and decision making across domains is seriously impaired.

The goal of the ArchiMate project is to provide this integration. By developing an architecture language and visualisation techniques that picture these domains and their relations, ArchiMate will provide the architect with instruments that support and improve the architecture process. Existing and emerging standards will be used or integrated whenever possible. ArchiMate will actively participate in national and international fora and standardisation organisations, to promote the dissemination of project results.

The project will deliver a number of results. First of all, we will provide a visual design language with adequate concepts for specifying interrelated architectures, and specific viewpoints for selected stakeholders. This will be accompanied by a collection of best practices and guidelines. Furthermore, ArchiMate will develop techniques that support architects in visualisation and analysis of architectures. Finally, project results will be validated in real-life cases within the participating organisations.

To have a real impact on the state of the art in architecture, the ArchiMate project consists of a broad consortium from industry and academia. ArchiMate's business partners are ABN AMRO, Stichting Pensioenfonds ABP, and the Dutch Tax and Customs Administration (Belastingdienst); its knowledge partners are Telematica Instituut, Ordina, Centrum voor Wiskunde en Informatica (CWI), the Leiden Institute for Advanced Computer Science (LIACS), and Katholieke Universiteit Nijmegen (KUN).

More information on ArchiMate and its results can be obtained from the project manager Marc Lankhorst (Marc.Lankhorst@telin.nl) or from the project website, archimate.telin.nl.

Management Summary

This report considers the presentation of enterprise architecture to stakeholders. The report contributes a framework for classification of viewpoints, examples of each class of viewpoints identified, and a set of viewpoint rules for derivation of viewpoints from ArchiMate models.

Viewpoints and Views

The essential notion in this deliverable is that of *viewpoints*, as defined by the ANSI/IEEE Std 1471-2000 (IEEE Computer Society, 2000) for architectural description. IEEE 1471 codifies in terms of recommended practices a number of concepts and terms of reference on which there is consensus and reflects "the generally accepted trends in practice for architecture description". The standard provides:

- A set of definitions for key terms like: acquirer, architect, architectural description, architectural models, architecture, life cycle model, system, system stakeholder, concerns, mission, context, architectural view, architectural viewpoint. As essential ideas we note a clear separation between an architecture and its architectural descriptions (defined as means to record architectures), and the central role of the relationship architectural viewpoint - architectural view (similar to the relationship class-object in OO programming).
- A conceptual framework, meant to explain how the key terms relate to each other in a conceptual model for architectural description. Using the UML notation for class diagrams, IEEE 1471 defines this model shown in Figure 1.

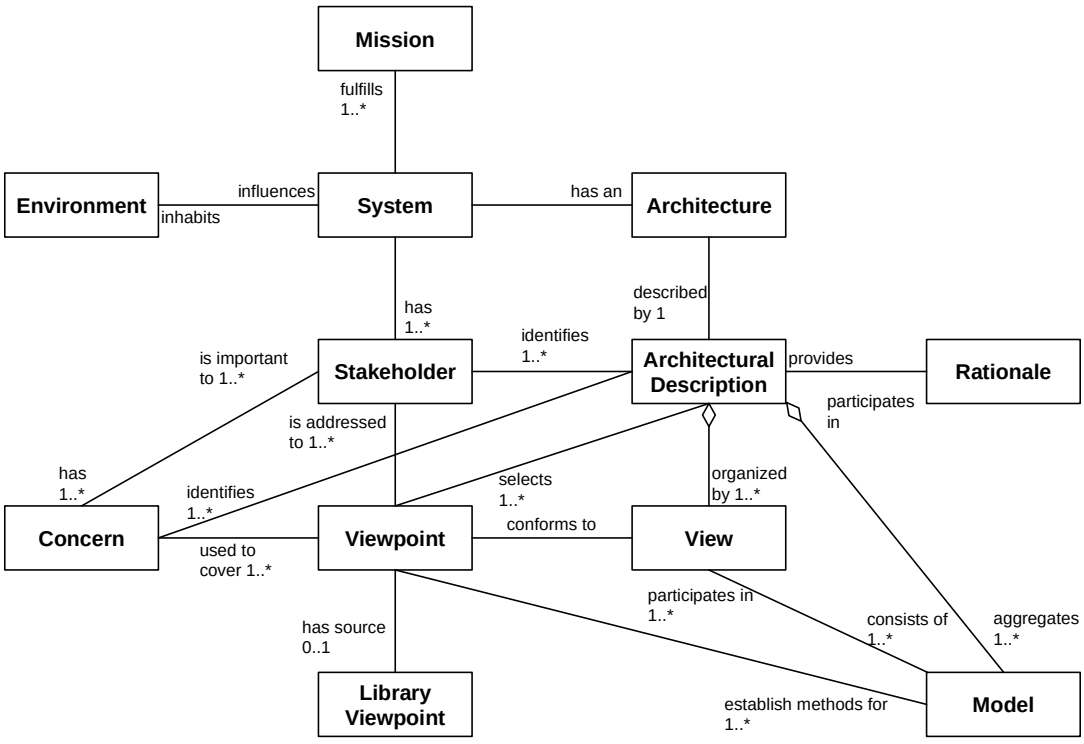


Figure 1. Conceptual model of architectural description (from (IEEE Computer Society, 2000)).

As can be seen from this figure, views and viewpoints are central to the standard's way of describing architectures.

Classification Framework

A classification framework for viewpoints is presented that assists architects and others in finding suitable viewpoints given their task at hand, i.e., the purpose that a view must serve and the content it should display. With the help of this framework, it is easier to find typical viewpoints that might be of help in a given situation. The framework distinguishes between three main types of purpose:

1. *Designing* – Design viewpoints support architects and designers in the design process from initial sketch to detailed design. Typically, design viewpoints consist of diagrams Typically, design viewpoints consist of diagrams, like those used in e.g. UML.
2. *Deciding* – Decision support views assist managers in the process of decision making by offering insight into cross-domain architecture relations, typically through projections and intersections of underlying models, but also by means of analytical techniques. Typical examples are cross-reference tables, landscape maps, lists and reports.
3. *Informing* – These viewpoints help to inform any stakeholder about the enterprise architecture, in order to achieve understanding, obtain commitment, and convince adversaries. Typical examples are illustrations, animations, cartoons, flyers, etc.

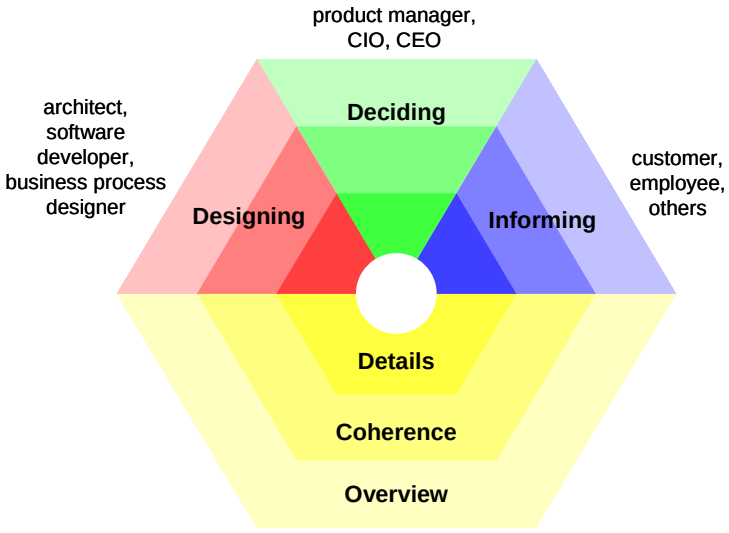


Figure 2. Classification framework for viewpoints.

For characterising the content of a view the following abstraction levels are defined:

1. *Details* – Views on the detailed level typically focus on one layer and one aspect from the ArchiMate framework (Figure 3). Typical stakeholders are a software engineer responsible for design and implementation of a software component or a process owner responsible for effective and efficient process execution. Examples of views are a Testbed process diagram and a UML class diagram.
2. *Coherence* – At the *coherence* abstraction level, either multiple layers are spanned or multiple aspects. Extending the view to more than one layer or aspects enables the stakeholder to focus on architecture relations like process-use-system (multiple layer) or application-uses-object (multiple aspect). Typical stakeholders are operational managers responsible for a collection of IT services or business processes.

3. *Overview* – The *overview* abstraction level addresses both multiple layers and multiple aspects. Typically, such overviews are addressed to enterprise architects and CEO, CIO.

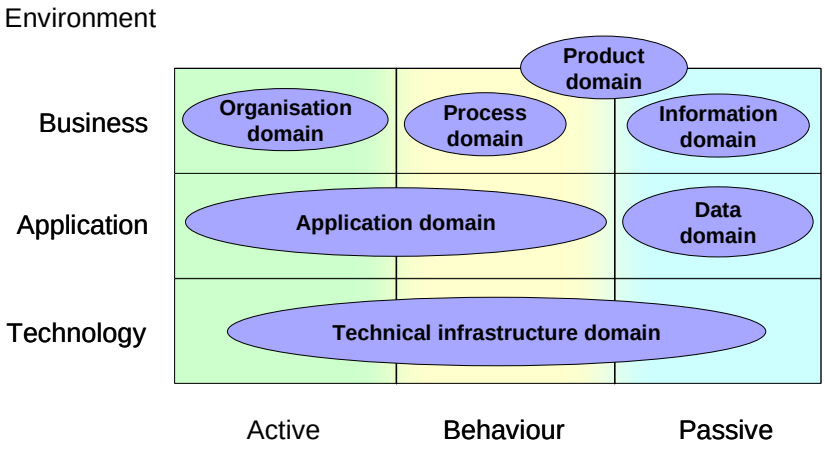


Figure 3. ArchiMate framework.

Example Viewpoints

Of each viewpoint type a number of examples is given. As an example of design viewpoints a set of diagram types is developed that makes the ArchiMate language better usable for architects. The landscape map (Figure 4a) visualises architecture relations between, for instance, business process, applications and product. Process illustration (Figure 4b) is a communication viewpoint that combines structure and business activity in one presentation.

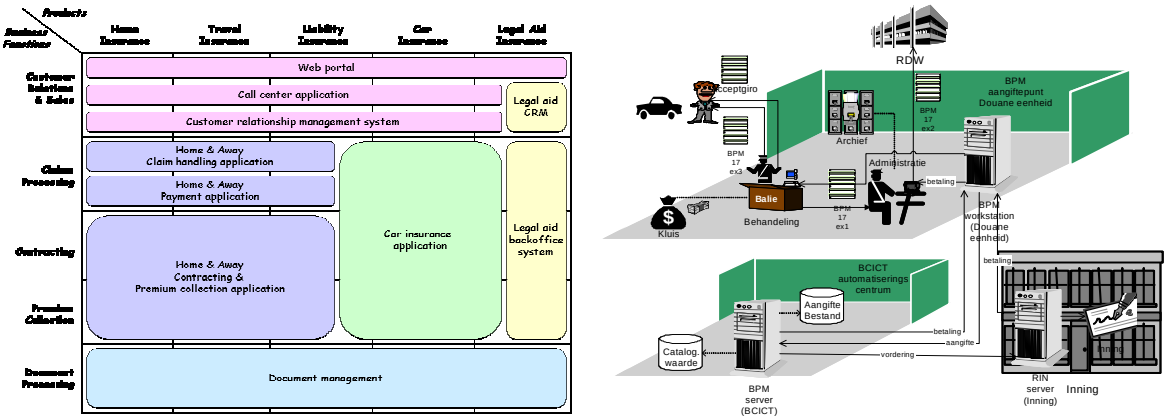


Figure 4 (a) Decision support view: landscape map
(b) Communication view: process illustration.

Viewpoint Rules and Viewpoints Platform

Besides developing usable architecture viewpoints, this report provides input for the realisation of views in software. Therefore, we describe how views can be derived from ArchiMate models using so-called selection and abstraction rules. These rules will be used to specify viewpoints in a formal way in order to automate the creation and presentation of views.

Table of Contents

1 Introduction

In this chapter the purpose and context of this document are outlined, relevant requirements are reviewed and the organisation of the document is explained.

1.1 Goal and Target Group

The goal of this report is to define a framework for understanding the presentation of architecture views, and to illustrate the framework by means of a collection of examples.

This report is targeted at enterprise architects and domain architects who want to publish their architectures and models to other stakeholders besides their own peers.

1.2 Context of this Report

Enterprise architectures and their descriptions are often complex and hard to understand. Architects therefore need ways to express these architectures as clearly as possible, both for their own understanding and for communication with other stakeholders. To date, there is no standard language for describing architectures, and they are often described in informal pictures that lack a well-defined meaning. This leads to misunderstandings, and makes it very difficult to provide tools for visualisation and analysis of these architectures.

Fundamental to developing a suitable architecture language paired with appropriate visualisation and analysis techniques is an understanding of the working process of the architect as follows. Figure 5 illustrates how initial ideas are formulated and communicated in an informal manner, for instance by drawing on a whiteboard or sketching on paper or writing a short memo. As soon as ideas become more stable and more people are involved in the development process, a more formal and rigorous language is needed to capture the design. To that purpose, a formal language like UML or Testbed comes into the picture in most cases supported by a modelling tool.

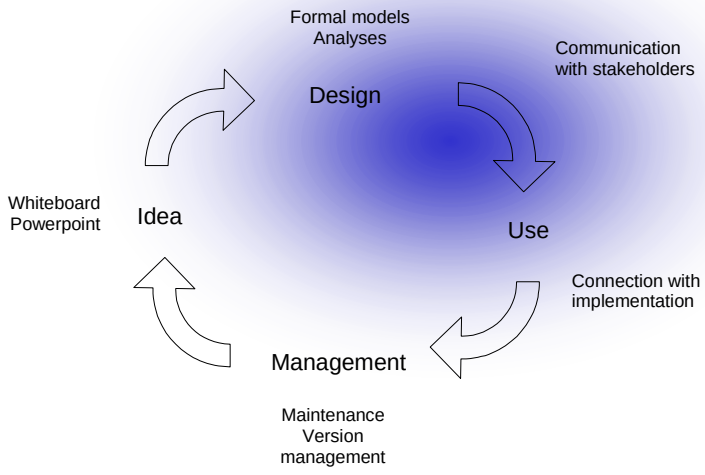


Figure 5. Architecture process.

Figure 6 illustrates the position of models within the scope of the project. Models described in a common ArchiMate language are the basis for different types of visualisation and analysis, which are the primary means for stakeholder communication. Different models and descriptions currently in use by architects, both at the business level and the application level, can be either mapped onto the common language or linked to the ArchiMate models.

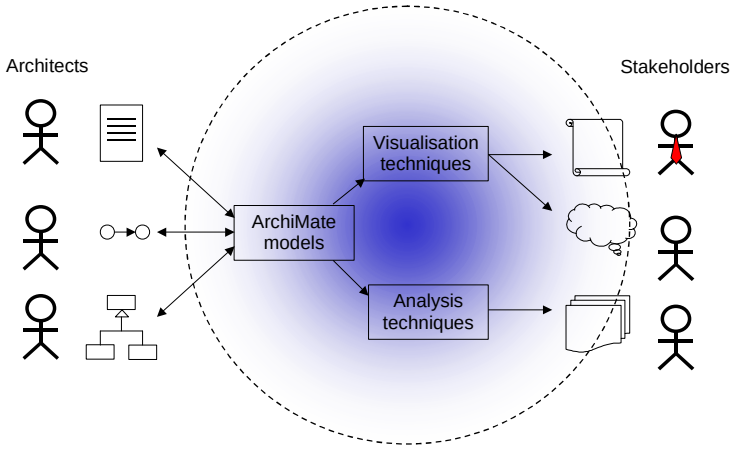


Figure 6. Scope of the ArchiMate project.

On the basis of the ArchiMate language visualisation techniques will be developed in order to provide architects and stakeholders with useful and easy-to-understand and manipulate presentations of their systems. Furthermore, architectures will develop over time, and changes need to be made. The complexity of enterprise architecture makes it difficult to determine the consequences of these changes. To overcome this problem, “what-if” analysis techniques will be developed that help in assessing the business and technical impact of architectural decisions.

1.3 Relation to Other ArchiMate Products

The foundation for the research on visualisation is the ArchiMate language (Jonkers *et al.*, 2003-2004); we assume that content to be visualised is specified in the ArchiMate language. The unit of visualisation is the view; a view is a stakeholder-specific selection of models and concepts combined with analysis techniques and visualised in a readable and usable way. Viewpoints specify how to create and present views.

The Viewpoints Infrastructure (Lankhorst *et al.*, 2003) provides the technology for specifying, creating and interacting with viewpoints. A viewpoint specification consists of different types of rules that are directly related to the architecture of the platform. The viewpoint examples and especially the rules give requirements for this platform.

The Tool Integration Workbench (Van Leeuwen *et al.*, 2003) is a tool integration framework and design environment at the same time. Through so-called tool adaptors it loads models specified in other modelling languages. The workbench translates the models to the ArchiMate language and allows the architect to interrelate these models using ArchiMate concepts. The relation to this work on view presentation is that the workbench is a viewpoint-driven environment configured by means of viewpoint specifications that consist of rules. This report gathers requirements for such rules. The example viewpoints show how to derive a view from an ArchiMate model.

1.4 Relation to Requirements

This document concerns the visualisation and viewpoints requirements from the requirements deliverable (Bosma et al., 2002):

- *4.1.1 Visualisation independence - Visualisation techniques and solutions should be independent of concepts, i.e. concepts can be modified or added without consequences for visualisation techniques.*
  Presentation of views is based on viewpoint rules for content selection and presentation that can easily be modified or replaced without affecting other viewpoints.
- *4.1.2 Visualisation generation - ArchiMate supports automatic generation of visualisations. The generation of visualisations*
  -has auto lay-out functionality. Moreover it must be possible to
  -modify the lay-out of a generated visualisation
  -generate new models while keeping the manually changed lay-out in tact
  -store and retrieve changes to the updated lay-out.
  The examples in this report account for the automatic selection and derivation of content based on viewpoint rules.
- *4.2.1 Viewpoint definition – A viewpoint definition must*
  -state the stakeholder(s) it is created for,
  -define the concerns covered by the viewpoint,
  -explain how views are created for this viewpoint (in terms of the concepts to be presented and the format of the presentation).
  Of each viewpoint defined in this report stakeholder(s) and concern(s) are given, and of each viewpoint it is explained how views can be created from ArchiMate models based on viewpoint rules.
- *4.2.2 Adaptability of viewpoints – Viewpoints must be adaptable and extensible independent of visualisation techniques.*
  Viewpoint specification are rule-based, and can be changed without affecting techniques, algorithms, etc., as these will be provided by the viewpoints infrastructure and are not part of the viewpoints themselves.
- *4.3.2 Viewpoint coverage - ArchiMate has to support often-used 'general' viewpoints, i.e. viewpoints for frequently occurring stakeholders.*
  This report does exactly this: it offers a collection of examples that represent often-used general viewpoints.

1.5 Organisation of this Report

In the next chapter, our example case around the fictitious insurance company ArchiSurance is introduced. This example is used throughout the remainder of the document. Chapter 1 introduces the general concepts of view and viewpoint, and provides the necessary background. Chapter 1 defines a framework for the classification of architecture views based on their purpose, content and abstraction level. Three types of viewpoints are distinguished: design, decision support and informing viewpoints. Subsequent chapters provide examples of each type. Especially useful is the set of so-called basic design viewpoints (Section 5.1), which provides the architect with a number of diagram-like subsets of the ArchiMate language, targeted at specific modelling purposes.

2 Example Case: ArchiSurance

In this chapter, we introduce ArchiSurance, a fictitious insurance company that will be used to illustrate the different viewpoints of the next chapters.

ArchiSurance, a company that originally provided home and travel insurance, has merged recently with two other insurance companies, PRO-FIT (car insurance) and LegallyYours (legal aid). To create insight in ArchiSurance's primary operations, the company is described in terms of its main business functions:

- Maintaining Customer Relations and Intermediary Relations: these business functions are responsible for the contacts of ArchiSurance with its customers and the intermediaries that sell its products. It handles customer questions and incoming claims, and performs marketing and sales.
- Contracting: this function does the 'back-office' processing of contracts. It performs risk analysis and ensures legally and financially correct contracts.
- Claims Handling: this function is responsible for handling insurance claims.
- Financial Handling: this function performs the regular premium collection, according to the insurance policies with customers as produced by Contracting, and handles the payment of insurance claims.
- Asset Management: this function manages the financial assets of ArchiSurance, e.g. by investing in stocks and bonds.

These business functions are very similar for most insurance companies and represent what is most stable about an enterprise.

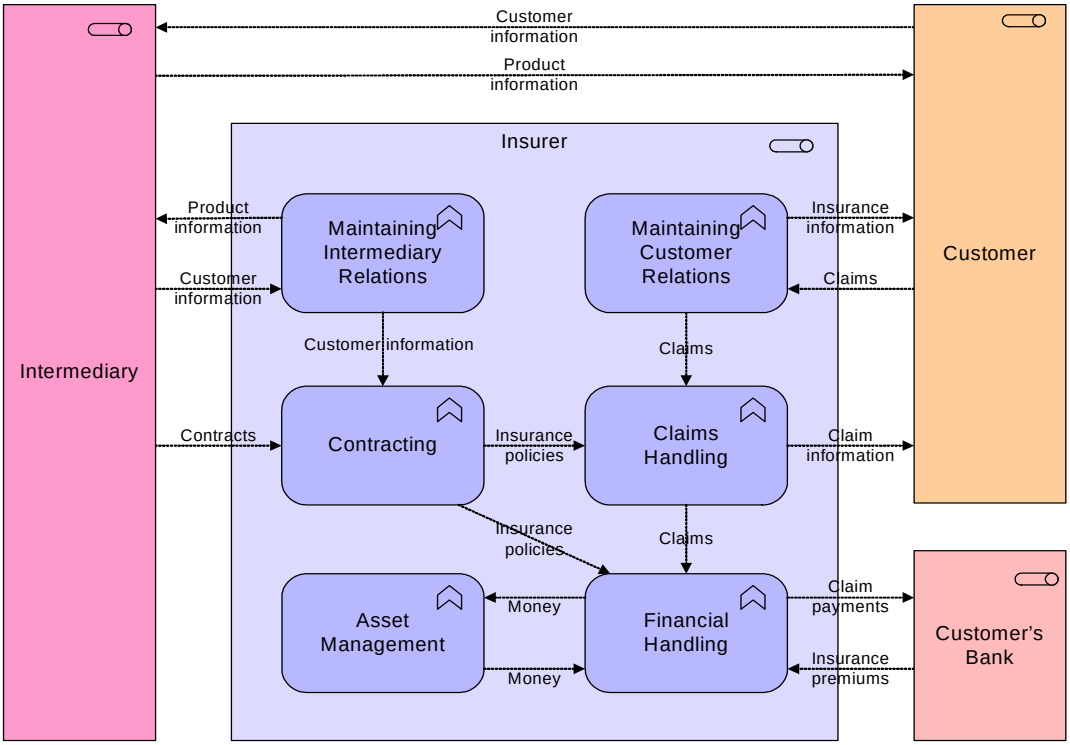


Figure 7. ArchiSurance business functions.

Post-merger integration is in full swing. The first step in the integration process has been the creation of a unified front office, comprising departments for managing relations with customers on the one hand, and intermediaries on the other hand. However, behind this front office are still three separate back offices:

- Home & Away: this department was the original pre-merger ArchiSurance, responsible for home and travel insurance.
- Legal Aid: this is the old LegallyYours, responsible for legal aid and liability insurance.
- Car: this department is the core of the old PRO-FIT and handles car insurance, including some legal aid.

Furthermore, ArchiSurance is in the process of setting up a Shared Service Center for document processing, which will handle all document streams and performs scanning, printing, and archiving jobs. The company's structure is shown in Figure 8.

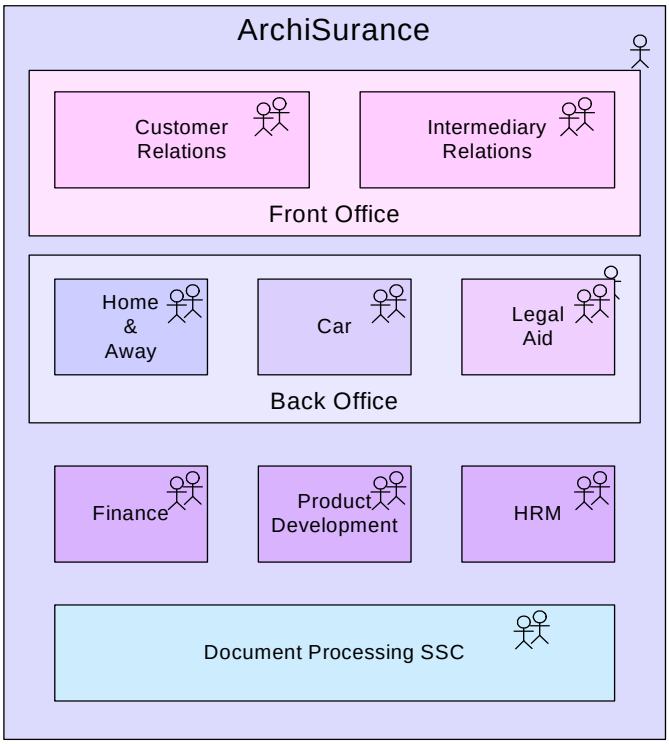


Figure 8. ArchiSurance departments.

As in many recently merged companies, IT integration is a problem. ArchiSurance want to move to a single CRM system, separate back-office systems for policy administration and finance, and a single document management system. However, Home & Away still have separate systems for the policy administration and the financial handling of premium collection and claims payment, and use the central CRM system and call center. The Car department have their own monolithic back-office system, but use the central CRM system and call center. The Legal Aid department have their own back- and front office systems (Figure 9).

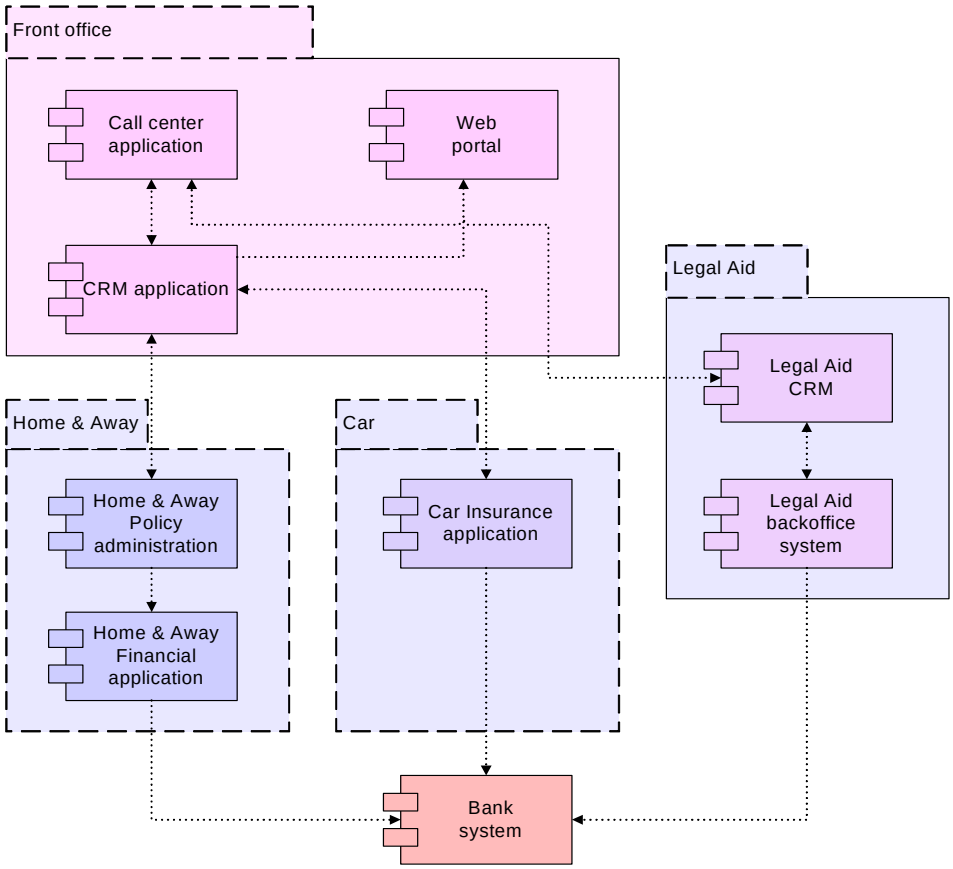


Figure 9. Applications grouped according to departments.

An important prerequisite for the changes in ArchiSurance's IT is that the IT integration should be "invisible" to ArchiSurance's clients: products & services remain the same. However, this is not a straightforward requirement. To illustrate the complexity of the relationships between products, business processes and IT support, Figure 10 shows the services provided by the Handle Claim business process, Figure 11 shows the relations between this business process and its supporting IT applications, and Figure 12 shows how a single service of these applications is realised. Note that this only shows these relations for a *single* business process! In general, many different business processes within the back office link the external products and services with the internal systems. This web of relations creates a major problem if we want to create insight in the IT support of ArchiSurance.

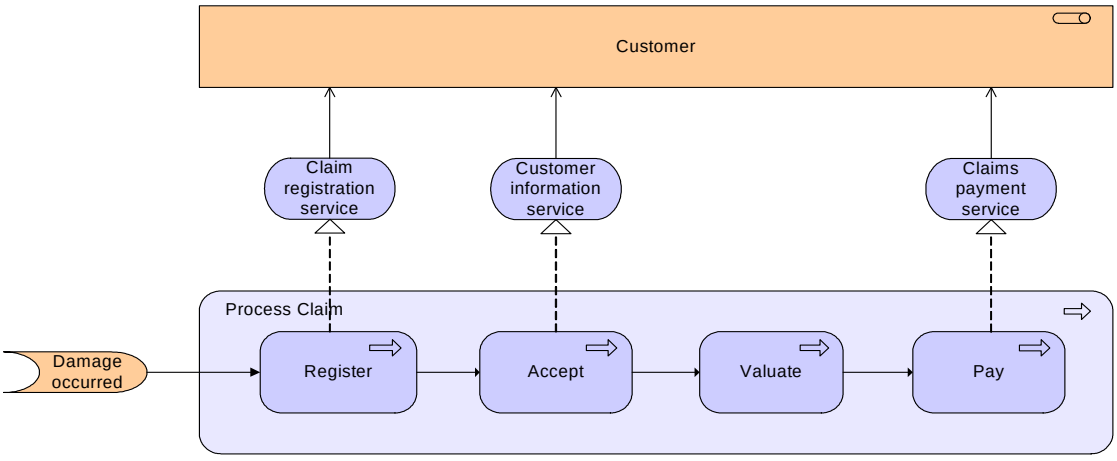


Figure 10. Services provided by the Handle Claim business process.

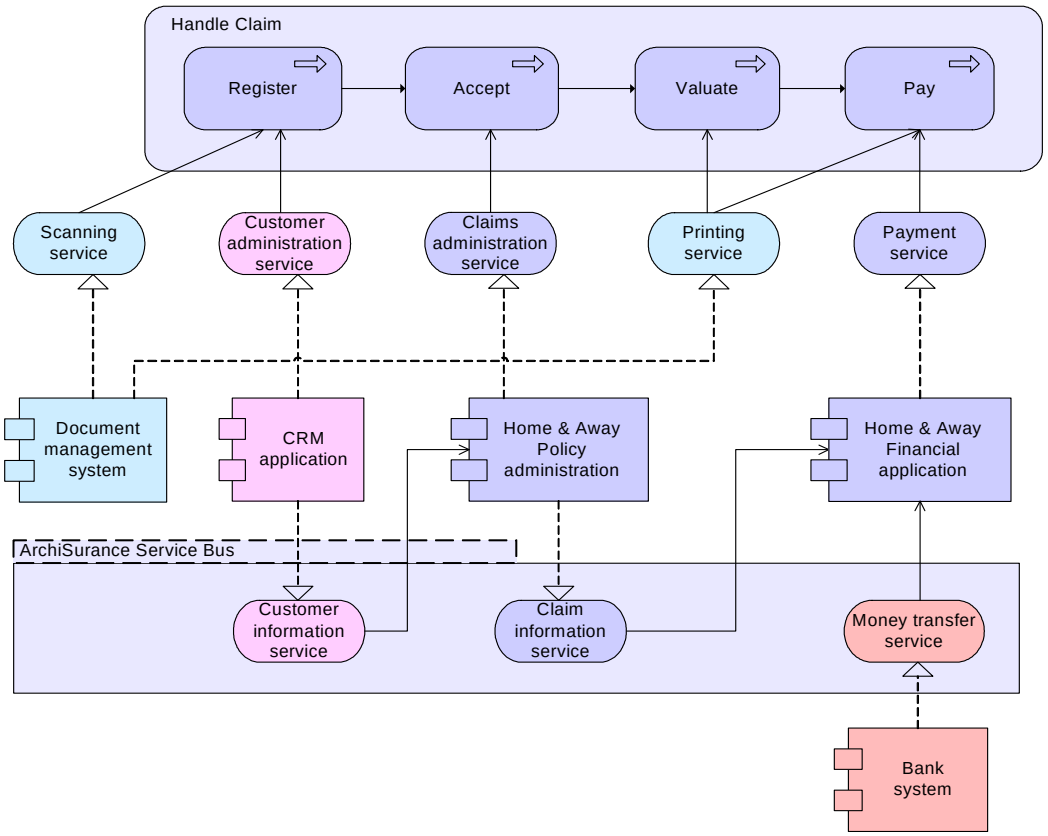


Figure 11. Relations between the Handle Claim business process and its IT support.

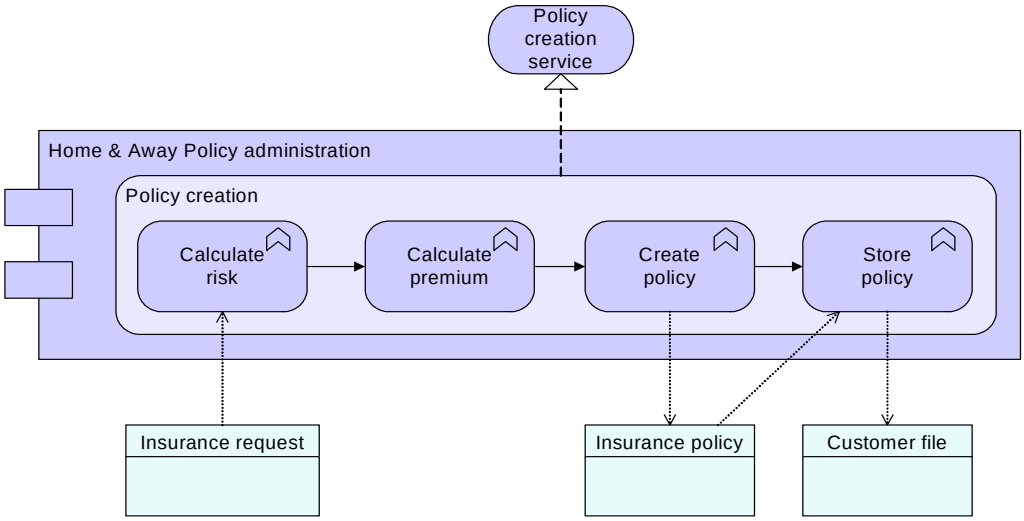


Figure 12. Realisation of the Policy creation service by the Home & Away Policy administration.

3 Architecture Views and Viewpoints

Establishing and maintaining a coherent enterprise architecture is clearly a complex task, because it involves many different people with differing backgrounds using various notations. In order to get a grip on this complexity, researchers have initially focused on the definition of architectural frameworks for classifying and positioning the various architectural descriptions with respect to each other. A prime example is the Zachman Framework for Enterprise Architecture (Sowa & Zachman, 1992). This two-dimensional framework identifies 36 views on architecture ("cells"), based on six levels (scope, enterprise, logical system, technology, detailed representations and functioning enterprise) and six aspects (data, function, network, people, time, motivation). A problem with looking at EA through the lens of an architectural framework like Zachman's is that it categorizes and divides architectural descriptions rather than providing insight into their coherence.

We advocate a more flexible approach in which architects and other stakeholders can define their own views on the enterprise architecture. In this approach views are specified by viewpoints. *Viewpoints* define abstractions on the set of models representing the enterprise architecture, each aimed at a particular type of stakeholder and addressing a particular set of concerns. Viewpoints can both be used to view certain aspects in isolation, and for relating two or more aspects.

3.1 Viewpoints for Enterprise Architecture

The notion of viewpoint-oriented architecture has been around for a while in requirements and software engineering. In the 1990's, a substantial number of researchers worked on what was phrased as "the multiple perspectives problem" (Finkelstein *et al*., 1992; Kotonya & Sommerville, 1992; Nuseibeh, 1994; Reeves, Marashi & Budgen, 1995). By this term they referred to the problem of how to organise and guide (software) development in a setting with many actors, using diverse representation schemes, having diverse domain knowledge and different development strategies. A general framework has been developed in order to address the diverse issues related to this problem ((Finkelstein *et al*., 1992; Kotonya & Sommerville, 1992). In this framework, a ViewPoint combines the notion of 'actor', 'role' or 'agent' in the development process with the idea of a 'perspective' or 'view' which an actor maintains. More precisely, ViewPoints are defined as loosely coupled, locally managed, distributable objects; thus containing identity, state and behaviour. A ViewPoint is more than a 'partial specification'; in addition, it contains partial knowledge of how to develop that partial specification. These early ideas on viewpoint-oriented software engineering have found their way into the IEEE-1471 standard for architectural description (IEEE Computer Society, 2000) on which we have based our definitions below.

Viewpoints are also prominently present in the ISO standardized Reference Model for Open Distributed Processing (RM-ODP) (ITU, 1996). The RM-ODP identifies five viewpoints from which to specify ODP systems, each focusing on a particular area of concern, i.e., enterprise, information, computational, engineering and technology. It is claimed that the ODP viewpoints form a necessary and sufficient set to meet the needs of ODP standards.

More recently, the term ‘viewpoint’ is also used in OMG’s Model Driven Architecture (MDA) initiative to refer to the different model types, i.e., platform-independent model (PIM) and platform-specific model (PSM) (Frankel, 2003). Hence we conclude that the use of viewpoints and architectural views are well-established concepts in software architecture.

In the domain of enterprise architecture, The Open Group’s TOGAF framework describes a taxonomy of views for different categories of stakeholders (Figure 13). Next to this description of views, TOGAF also provides guidelines for the development and use of viewpoints and views in enterprise architecture models.

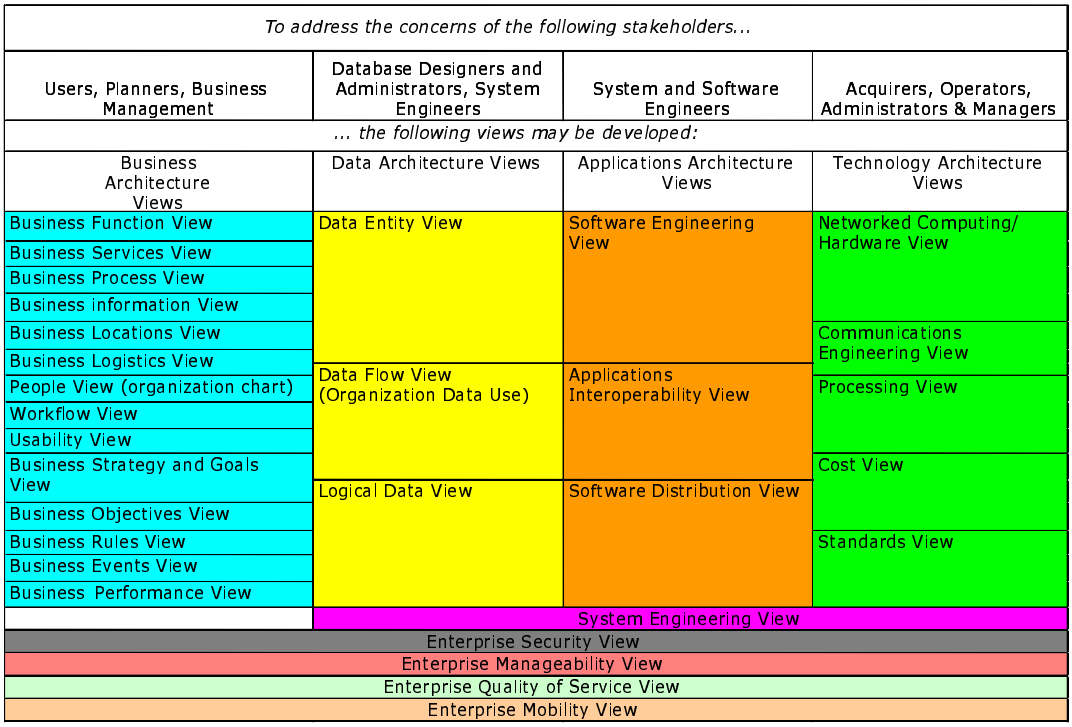


Figure 13. Views according to the TOGAF framework (The Open Group, 2002).

3.2 Views, Viewpoints, and Stakeholders

In general, a *view* is defined as a part of an architecture description that addresses a set of related concerns and is addressed to a set of stakeholders. A view is specified by means of a *viewpoint*, which prescribes the concepts, models, analysis techniques and visualisations that are provided by the view. Simply put, a view is what you see, and a viewpoint is where you are looking from.

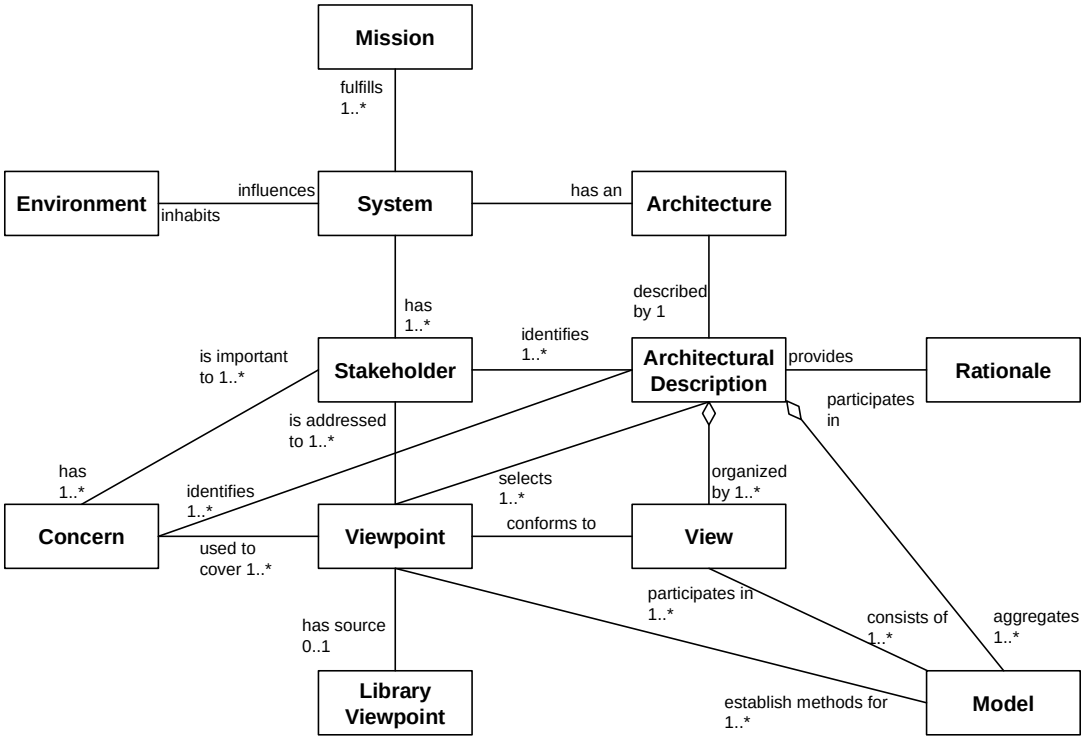


Figure 14. Conceptual model of architectural description (from (IEEE Computer Society, 2000)).

Viewpoints are a means to focus on particular aspects of the architecture. These aspects are determined by the concerns of a stakeholder with whom communication takes place. What should and should not be visible from a specific viewpoint is therefore entirely dependent on the argumentation with respect to a stakeholder's concerns.

Viewpoints are designed for the purpose of communicating certain aspects of an architecture. The communication enabled by a viewpoint can be strictly informative, but, in general, will be bi-directional. The architect informs stakeholders, and stakeholders give their feedback (critique or consent) on the presented aspects. What is and what is not shown in a view depends on the scope of the viewpoint and on what is relevant to the concerns of the stakeholder. Ideally, these are the same; i.e. the viewpoint is designed with specific concerns of a stakeholder in mind. Relevance to a stakeholders concern, therefore, is *the* selection criterion that is used to determine which objects and relations are to appear in a view.

The following are examples of stakeholders and concerns as a basis for the specification of viewpoints:

- End user. E.g.: What are the consequences for his work and workplace?
- Architect. What is the consequence for the maintainability of a system, with respect to corrective, preventive and adaptive maintenance?
- Upper-level management. How can we ensure our policies are followed in the development and operation of processes and systems? What is the impact of decisions (on personnel, finance, ICT, etcetera)?
- Operational manager, responsible for exploitation or maintenance. E.g.: What new technologies are there to prepare for? Is there a need to adapt maintenance processes? What is the impact of changes to existing applications? How secure are my systems?

- Project manager, responsible for the development of new applications. What are the relevant domains and their relations, what is the dependence of business processes on the applications to be built? What is their expected performance?
- Developer. What are the modifications with respect to the current situation that need to be done?

4 Classification of Architecture Views

In this chapter, we introduce a classification framework that helps architects and others to find the right viewpoint(s) given their task at hand, i.e., the purpose that a view must serve and the content it should display.

4.1 Viewpoint Classification Framework

Our viewpoint classification framework is based on two dimensions, *purpose* and *content*. The framework distinguishes between three main types of purpose:

- *Designing* – Design viewpoints support architects and designers in the design process from initial sketch to detailed design. Typically, design viewpoints consist of diagrams, like those used in e.g. UML.

- *Deciding* – Decision support views assist managers in the process of decision making by offering insight into cross-domain architecture relations, typically through projections and intersections of underlying models, but also by means of analytical techniques. Typical examples are cross-reference tables, landscape maps, lists and reports.

- *Informing* – These viewpoints help to inform any stakeholder about the enterprise architecture, in order to achieve understanding, obtain commitment, and convince adversaries. Typical examples are illustrations, animations, cartoons, flyers, etc.

With the help of this framework, it is easier to find typical viewpoints that might be useful in a given situation. This implies that we do not provide an orthogonal categorisation of each viewpoint into one of three classes; these categories are not exclusive in the sense that a viewpoint in one category cannot be applied to achieve another type of support. For instance, some decision support viewpoints may be used to communicate to any other stakeholders as well.

Table 1. Viewpoint purpose.

	TYPICAL STAKEHOLDER(S)	PURPOSE	EXAMPLES
DESIGNING	architect. software developer, business process designer	navigate, design, support design decisions, compare alternatives	UML diagram, BPMN diagram, Testbed diagram
DECIDING	manager, CIO, CEO	decision-making	cross-reference table, landscape map, list, report
INFORMING	employee, customer, others	explain, convince, obtain commitment	animation, cartoon, process illustration, chart

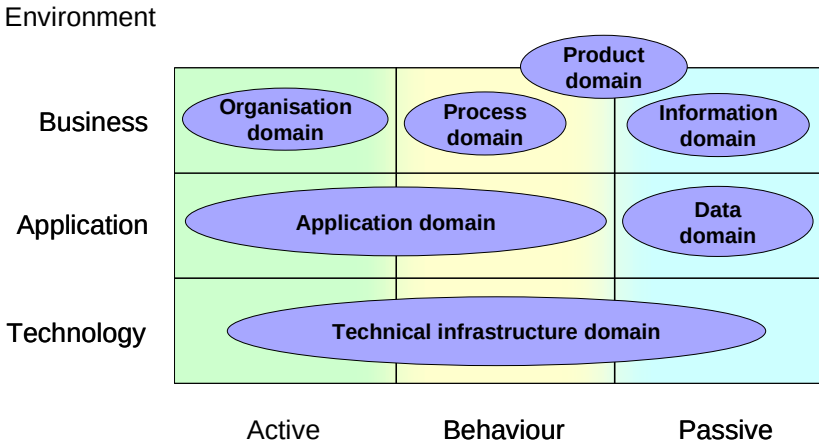


Figure 15. The ArchiMate framework.

For characterising the content of a view we define the following abstraction levels:

- *Details* – Views on the detailed level are typically focussed on one layer and one aspect from the ArchiMate framework (Figure 15). Typical stakeholders are a software engineer responsible for design and implementation of a software component or a process owner responsible for effective and efficient process execution. Examples of views are a Testbed process diagram and a UML class diagram.

- *Coherence* – At the *coherence* abstraction level, either multiple layers are spanned or multiple aspects. Extending the view to more than one layer or aspect enables the stakeholder to focus on architecture relations like process-uses-system (multiple layer) or application-uses-object (multiple aspect). Typical stakeholders are operational managers responsible for a collection of IT services or business processes.

- *Overview* – The *overview* abstraction level addresses both multiple layers and multiple aspects. Typically such overviews are addressed to enterprise architects, and decision makers such as CEOs and CIOs.

Table 2. Viewpoint abstraction levels.

	TYPICAL STAKEHOLDER(S)	PURPOSE	EXAMPLES
DETAILS	software engineer, process owner	design, manage	UML diagram, BPMN diagram, flowchart
COHERENCE	operational managers	Analyse dependencies, impact-of-change	views expressing architecture relations like 'use', 'realise' and 'assign'
OVERVIEW	enterprise architect, CIO, CEO	change management	landscape map

In Figure 16, the dimensions of purpose and abstraction level are visualised in a single picture, together with examples of stakeholders.

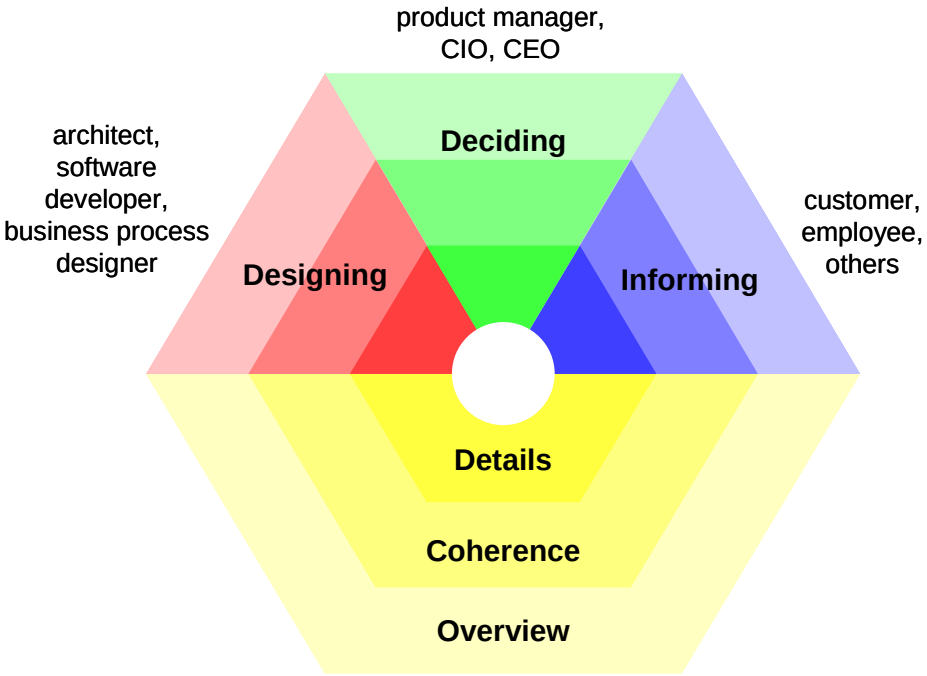


Figure 16. Classification of enterprise architecture viewpoints.

4.2 Position of the Example Viewpoints

In the following chapters, several example viewpoints will be defined each of which can be positioned within this framework as follows (see also Figure 17):

- Basic design viewpoints (section 5.1): These viewpoints are all diagrams. Some viewpoints are multiple-aspect and multiple-layer overviews.
- Layered viewpoint (section 5.2): The layered view is an overview diagram that addresses multiple layers and multiple aspects.
- Design process viewpoints (section 5.3): each of the views presented in this section is based on the same diagram; differences are in abstraction level and notation.

- Landscape viewpoint (Section 6.1): the landscape view is a typical example of a decision support view: an ArchiMate model is projected on a two dimensional chart while a third dimension is added by assigning values to the entries.
- Process illustration viewpoint (Section 7.1): the process illustration view is an illustration of workflow for employees and managers. Process illustrations can be on the detailed, coherence or overview abstraction level.

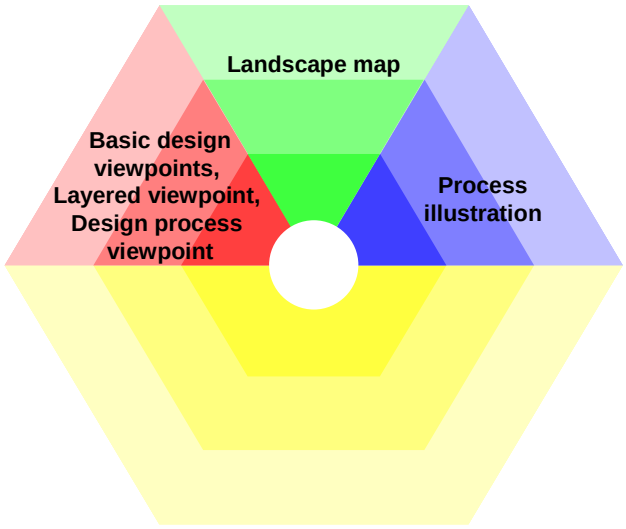


Figure 17. Position of the example viewpoints.

4.3 Viewpoint Rules

As we have described previously (Lankhorst *et al*., 2003a), it should be possible to construct viewpoints from basic elements: individual 'viewpoint rules' that govern the creation, visualisation and manipulation of views.

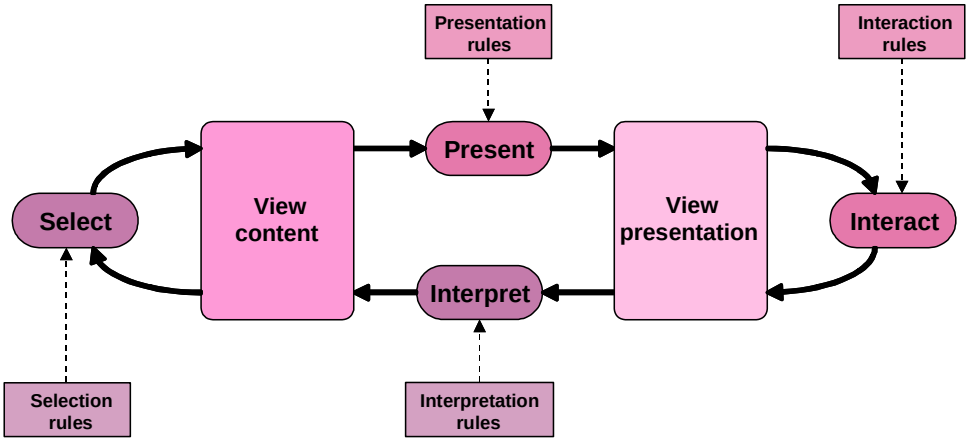


Figure 18. Views governed by viewpoint rules.

Figure 18 shows the four main types of viewpoint rules that are used in creating and manipulating views:

- Selection rules determine which elements from the architecture are to be shown in the view. This category not only comprises rules for simply choosing the elements themselves, but may also entail rules for abstraction, aggregation, refinement, and global constraints.

- Presentation rules determine how these elements are shown in the view. These rules determine e.g. symbols, fonts, line styles, and colours.
- Interaction rules determine how the user can manipulate the resulting view. They may for example constrain the edits allowed based on the user's role.
- Interpretation rules determine how the user's manipulations propagate to the underlying architecture. Especially when the user manipulates an abstracted or aggregated object, this propagation is non-trivial.

One of the goals of this report is to identify concrete and useful examples of these rules that serve as input and requirements to the viewpoints infrastructure described in (Lankhorst *et al.*, 2003).

5 Design Viewpoints

In this chapter three types of design viewpoints are presented. The first type, called basic design viewpoints defines a set of diagram types for the ArchiMate language. In addition to a number of aspect- or layer-specific diagrams, a set of *coherence* diagram types are introduced that cover multiple layers and/or multiple aspects. The second type is the layered view, which is an *overview* type of view that presents multiple aspects and multiple layers in one layered diagram. The third type of view shows how form and content of a view can be adapted to the needs of stakeholders using a set of abstraction and presentation rules.

5.1 Basic Design Viewpoints

The most basic type of viewpoint is the simple selection of a relevant subset of the ArchiMate concepts and the representation of that part of an architecture that is expressed in the concepts in this selection. This is sometimes called a 'diagram', akin to e.g. the UML diagrams.

From any given element in a model, we can define viewpoints in four metaphorical directions (inspired by Veryard 2004):

1. 'inwards', toward the internal composition of the element;
2. 'upwards', towards the elements that are supported by it;
3. 'downwards', toward its realisation by other elements;
4. 'sideways', towards peer elements with which it cooperates.

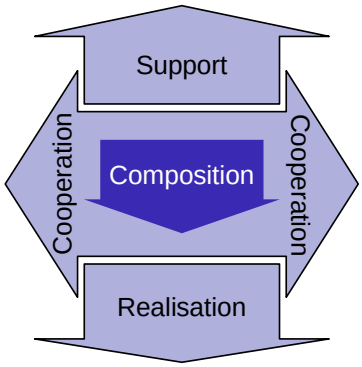


Figure 19. Metaphorical directions for viewpoints.

For the 'composition' viewpoints, we start from the basic structure of our modelling language. In its elementary form, the generic metamodel that is behind the language consists of active structural elements such as actors, behavioural elements such as functions and processes, and passive informational elements such as business and data objects, which are processed by the active elements in the course of their behaviour (see also Figure 15).

From this basic structure, we can deduce a first set of viewpoint types, containing three viewpoints that are centered around one specific type of concept:

1. active elements, e.g., the composition of a business actor from subactors, i.e., an organisation structure;
2. behaviour elements, e.g., the structure of a business process in terms of subprocesses;
3. passive elements, e.g., the information structure in terms of data objects.

Although these viewpoints take a specific type of concept and its structure as their focus, they are not limited to these concepts, and closely related concepts are also included.

For the 'upwards' support of elements in their environment, the active elements offer interfaces, through which their services can be used. 'Downwards', services are realised by processes and functions, and application components are deployed on infrastructure elements. 'Sideways' cooperation is achieved through collaborations between active elements and their behaviour in the form of interactions, and flows of information and value that relate the elements. Passive elements often play a role in these relations, e.g. by being passed from one element to another, but are not the focus. Hence we concentrate on the relations between the active and behaviour elements.

In each of these viewpoint types, concepts from the three layers of business, application, and technology may be used. However, not every combination of these would give meaningful results; in some cases, for example, separate viewpoints for the different layers are advisable. Based on common architectural practice, our experiences with the use of ArchiMate models in practical cases, and on the diagrams used in other languages like UML, we have selected the most useful combinations in the form of a 'standard' set of basic viewpoints to be used with the ArchiMate concepts (Table 3).

Table 3. Design viewpoints.

COMPOSITION	COOPERATION
Organisation (active): p. 22 *Business Function* (behaviour), p. 24 *Business Process* (behaviour), p. 26 *Information Structure* (passive), p. 28 *Application Structure* (active), p. 30 *Application Behaviour* (behaviour), p. 32 *Infrastructure* (active), p. 34	*Actor Cooperation*, p. 36 *Business Process Cooperation*, p. 39 *Application Cooperation*, p. 41
SUPPORT	REALISATION
Product, p. 44 *Application Usage*, p. 46 *Infrastructure Usage*, p. 48	*Service Realisation*, p. 50 *Implementation & Deployment*, p. 52

Some of these viewpoints have a scope that is limited to a single layer or aspect: the Business Function and Business Process viewpoints show the two main perspectives on the business behaviour; the Organisation viewpoint depicts the structure of the enterprise in terms of its departments, roles, etc.; the Information Structure viewpoint describes the information and data used; the Application Structure, Behaviour and Cooperation viewpoints contain the applications and components and their mutual relations, and the Infrastructure viewpoint shows the infrastructure and platforms underlying the enterprise's information

systems in terms of networks, devices, and system software. Other viewpoints link multiple layers and/or aspects: the Actor Cooperation and Product viewpoints relate the enterprise to its environment; the Application Usage viewpoint relates applications to their use in e.g. business processes; and the Deployment viewpoint shows how applications are mapped onto the underlying infrastructure. The figures below illustrate the coverage of these viewpoints.

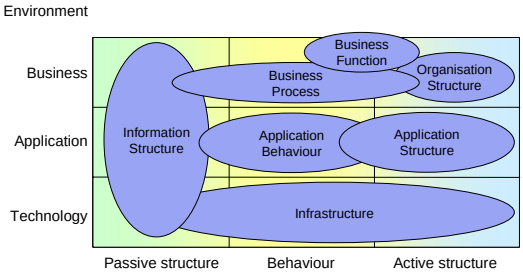


Figure 20. Composition viewpoints.

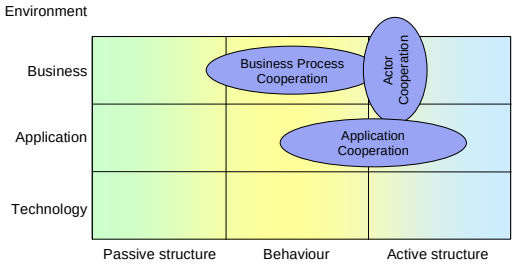


Figure 21. Cooperation viewpoints.

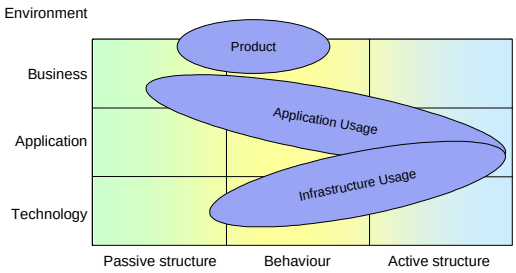


Figure 22. Support viewpoints.

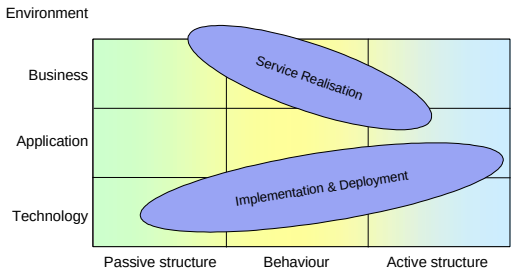


Figure 23. Realisation viewpoints.

Note that it is explicitly *not* the intention to limit the user of the ArchiMate language to these viewpoints, and neither do we expect that an architect draws all these diagrams in a given situation! They are meant to assist the modeller in choosing the contents of a view, but combinations or subsets of these viewpoints could well be useful in specific situations.

5.1.1 Organisation Viewpoint

The Organisation viewpoint shows the structure of an internal organisation of the enterprise, department, or other organisational entity. It can be represented in the form of a nested block diagram, but also in more traditional ways like the organigram.

An Organisation view is typically used to identify authority, compentencies, and responsibilities within an organisation.

Table 4. Organisation viewpoint.

VIEWPOINT NAME	Organisation
STAKEHOLDERS	Enterprise, process, domain architects Managers, employees
CONCERNS	Structure of the organisation, competencies, responsibilities, authority
PURPOSE	Designing, deciding, informing
ABSTRACTION LEVEL	Details
LAYERS	Business
ASPECTS	Active

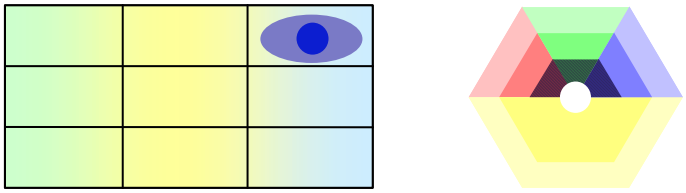


Figure 24. Position of the Organisation viewpoint in the conceptual and viewpoint frameworks.

Contents

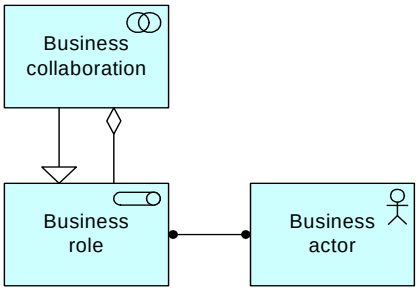


Figure 25. Concepts in the Organisation viewpoint.

Example

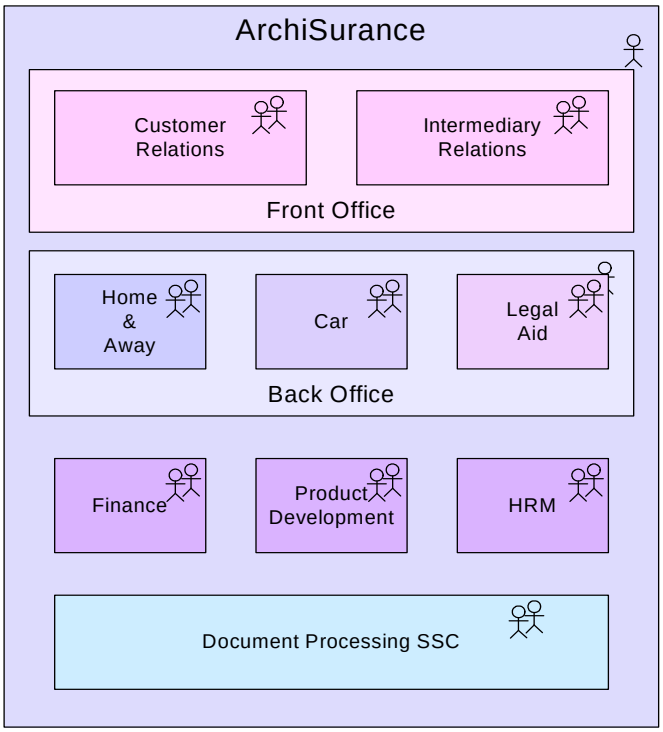


Figure 26. The organisation structure of ArchiSurance.

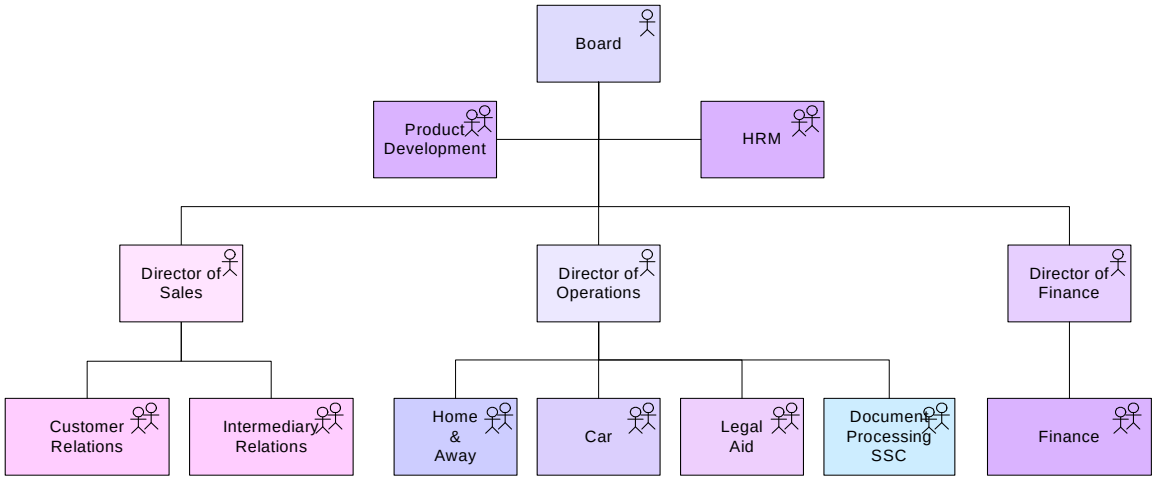


Figure 27. ArchiSurance organigram.

5.1.2 Business Function Viewpoint

The Business Function viewpoint shows the main business functions of an organisation and their relations in terms of the flows of information, value or goods between them. Business functions are used to represent what is most stable about a company in terms of the primary activities it performs, regardless of organisational changes or technological developments. Business function architectures of companies that operate in the same market therefore often exhibit close similarities. The Business Function viewpoint thus provides high-level insight in the general operations of the company, and can be used to identified necessary compentencies, or to structure an organisation according to its main activities.

Table 5. Business Function viewpoint.

VIEWPOINT NAME	Business Function
STAKEHOLDERS	Enterprise, process, domain architects
CONCERNS	Identification of essential activities Identification of compentencies Reduction of complexity
PURPOSE	Designing
ABSTRACTION LEVEL	Coherence
LAYERS	Business
ASPECTS	Behaviour, (active)

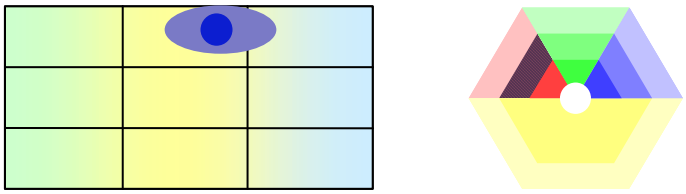


Figure 28. Position of the Business Function viewpoint in the conceptual and viewpoint frameworks.

Contents

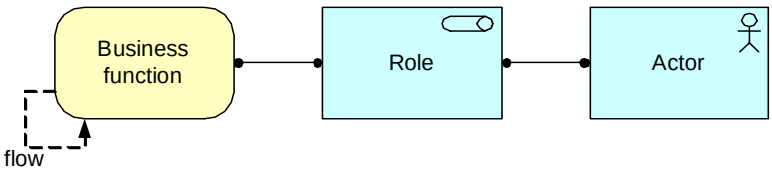


Figure 29. Concepts in the Business Function viewpoint.

Example

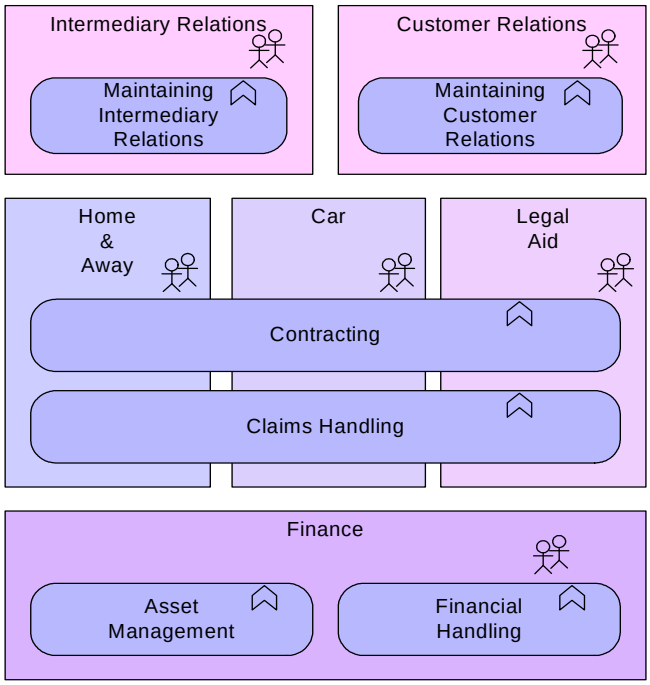


Figure 30. Business functions of ArchiSurance, assigned to its departments.

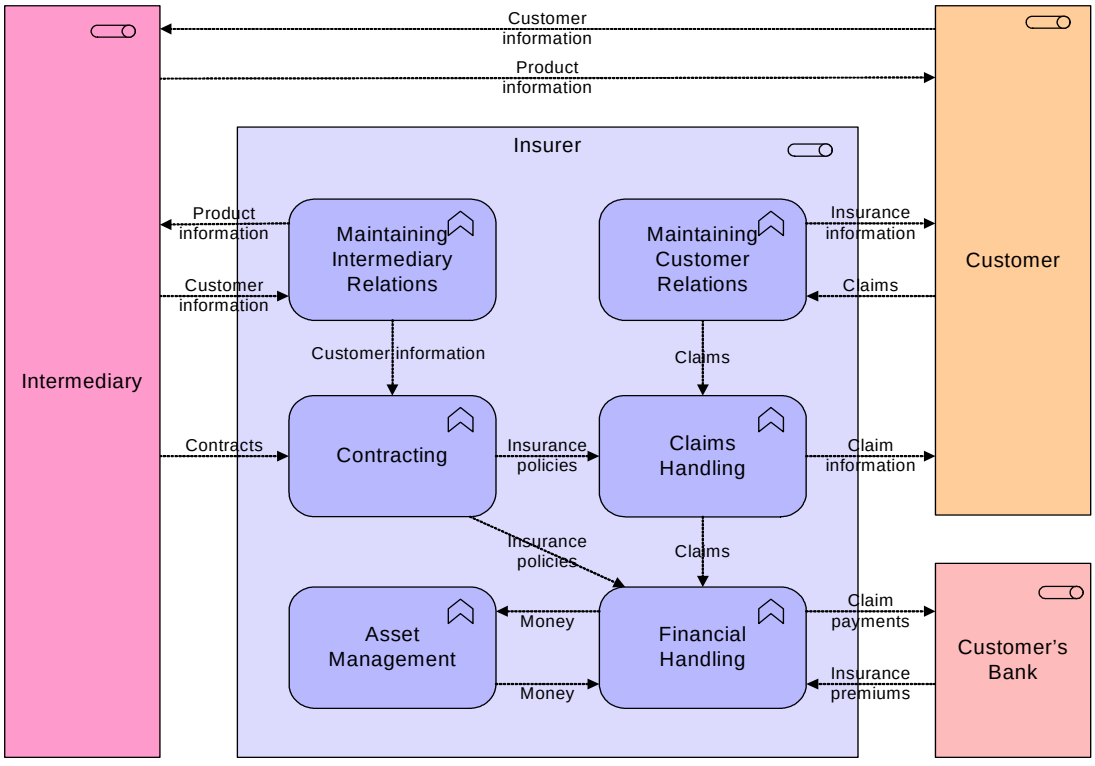


Figure 31. Business functions and information and money flows.

5.1.3 Business Process Viewpoint

The Business Process viewpoint is used to show the high-level structure and composition of one or more business processes. Next to the processes themselves, this viewpoint contains other directly related concepts, such as:

- the services a business process offers to the outside world, showing how a process contributes to the realisation of the company's products;
- the assignment of business processes to roles, which gives insight into the responsibilities of the associated actors;
- the information used by the business process.

Each of these can be regarded as a 'sub-viewpoint' of the Business Process viewpoint. Below, we give examples of the resulting views.

Table 6. Business Process viewpoint.

VIEWPOINT NAME	Business Process
STAKEHOLDERS	Process, domain architects Operational managers
CONCERNS	Structure of business processes Consistency & completeness Responsibilities
PURPOSE	Designing
ABSTRACTION LEVEL	Details
LAYERS	Business, (application)
ASPECTS	Behaviour, (active), (passive)

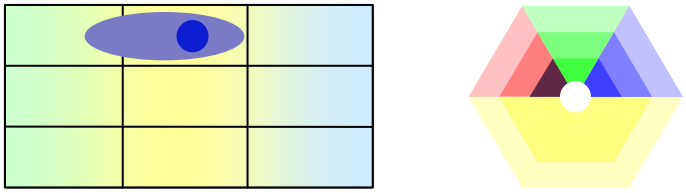


Figure 32. Position of the Business Process viewpoint in the conceptual and viewpoint frameworks.

Contents

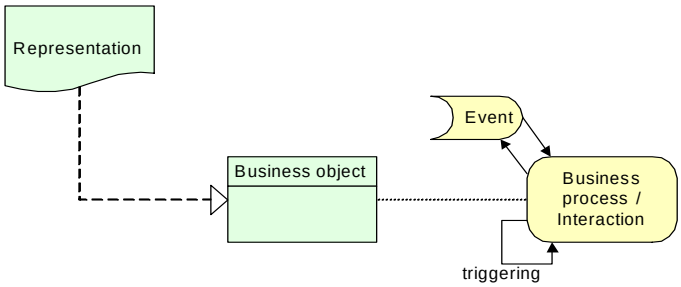


Figure 33. Concepts in the Business Process viewpoint.

Example

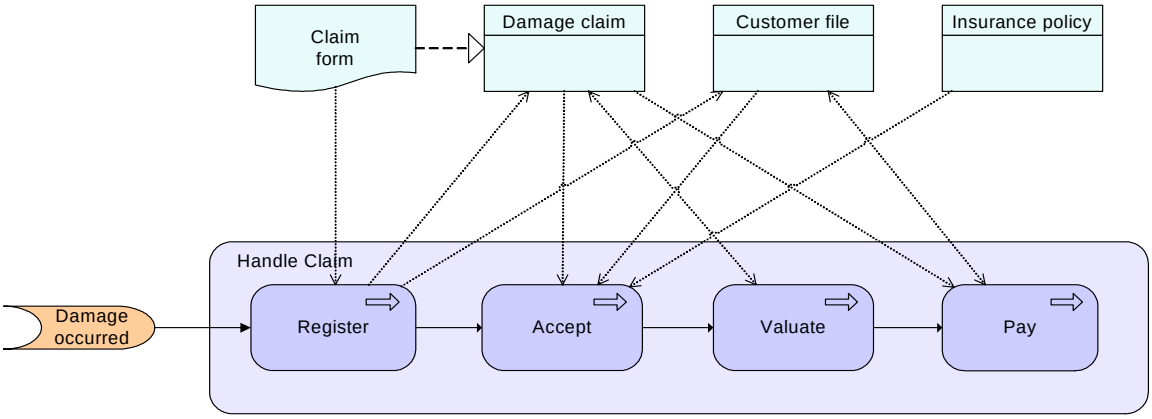


Figure 34. The Handle Claim business process and its use of information.

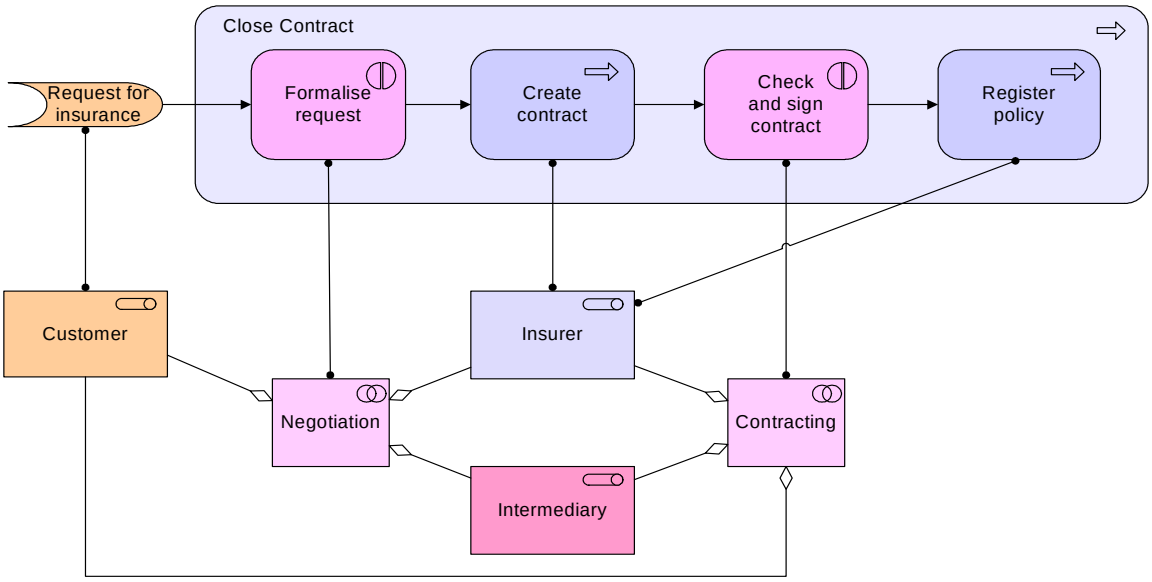


Figure 35. Assignment of the subprocesses of the Close Contract business process to business roles.

5.1.4 Information Structure Viewpoint

The Information Structure viewpoint is basically identical to the traditional information models created in the development of almost any information system. It shows the structure of the information used in the enterprise or in a specific business process or application, in terms of data types or (object-oriented) class structures. Furthermore, it may show how the information at the business level is represented at the application level in the form of the data structures used there, and how these are then mapped onto the underlying infrastructure, e.g. by means of a database schema.

Table 7. Information Structure viewpoint.

VIEWPOINT NAME	Information Structure
STAKEHOLDERS	Domain, information architects
CONCERNS	Structure and dependencies of information and data used Consistency & completeness
PURPOSE	Designing
ABSTRACTION LEVEL	Details
LAYERS	Business, application, (technology)
ASPECTS	Passive

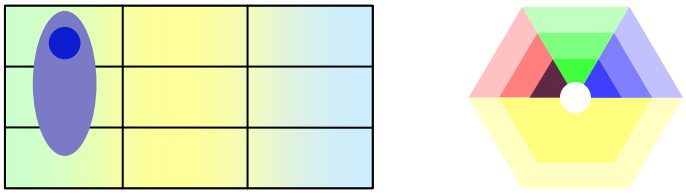


Figure 36. Position of the Information Structure viewpoint in the conceptual and viewpoint frameworks.

Contents

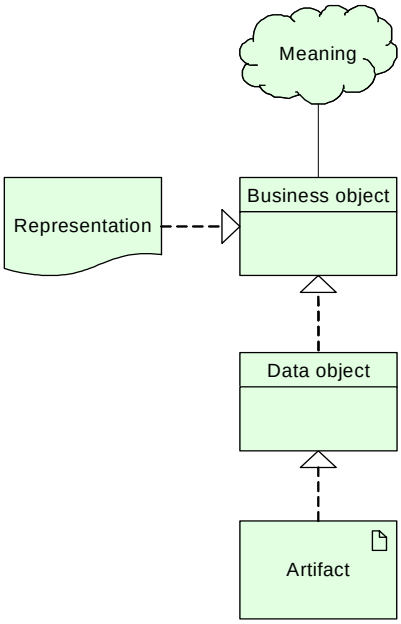


Figure 37. Concepts in the Information Structure viewpoint.

Example

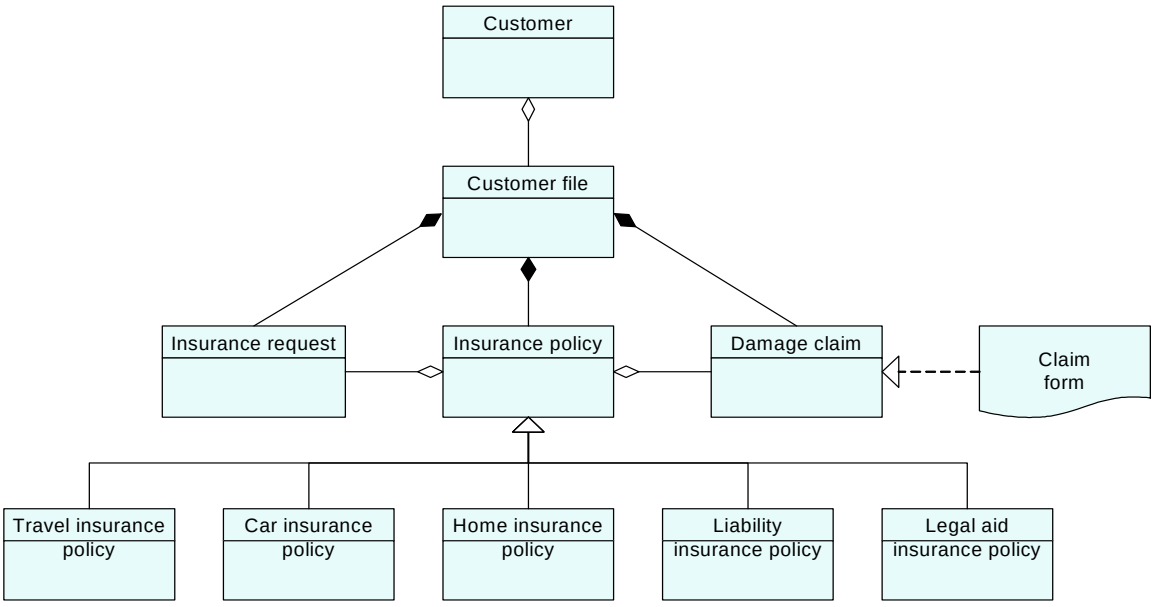


Figure 38. Information model of ArchiSurance.

5.1.5 Application Structure Viewpoint

The Application Structure viewpoint shows the structure of one or more applications or components. This viewpoint is useful in designing or understanding the main structure of applications or components and the associated data, e.g. to create a first step work breakdown structure for building a system, or in identifying legacy parts suitable for migration.

Table 8. Application Structure viewpoint.

VIEWPOINT NAME	Application Structure
STAKEHOLDERS	Enterprise, application, domain architects
CONCERNS	Structureof applications Consistency & completeness Reduction of complexity
PURPOSE	Designing
ABSTRACTION LEVEL	Details
LAYERS	Application
ASPECTS	Active, (passive)

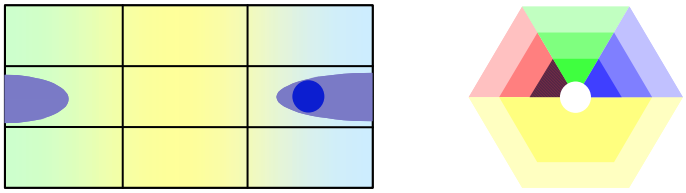


Figure 39. Position of the Application Structure viewpoint in the conceptual and viewpoint frameworks.

Contents

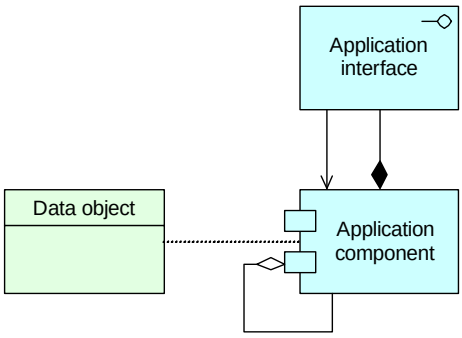


Figure 40. Concepts in the Application Behaviour viewpoint.

Example

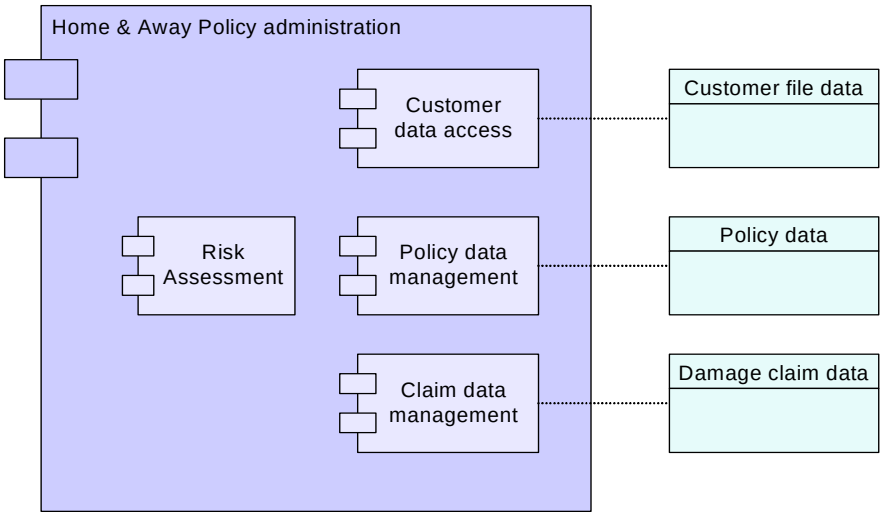


Figure 41. Main structure of the Home & Away Policy administration.

5.1.6 Application Behaviour Viewpoint

The Application Behaviour viewpoint describes the internal behaviour of an application or component, e.g. as it realises one or more application services. This viewpoint is useful in designing the main behaviour of applications or components, or in identifying functional overlap between different applications.

Table 9. Application Behaviour viewpoint.

VIEWPOINT NAME	Application Behaviour
STAKEHOLDERS	Enterprise, application, domain architects
CONCERNS	Structure, relations and dependencies of applications Consistency & completeness Reduction of complexity
PURPOSE	Designing
ABSTRACTION LEVEL	Coherence
LAYERS	Application
ASPECTS	Active, behaviour, (information)

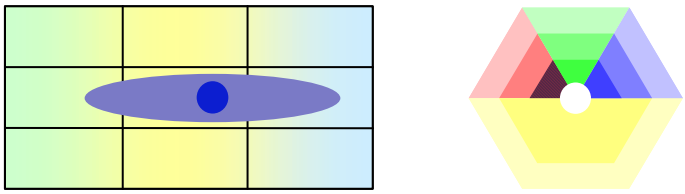


Figure 42. Position of the Application Behaviour viewpoint in the conceptual and viewpoint frameworks.

Contents

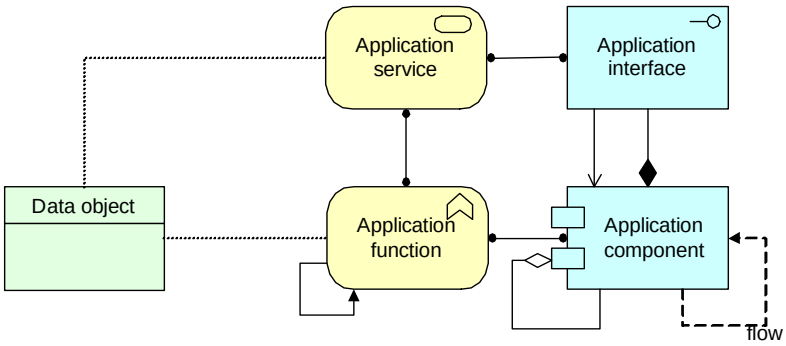


Figure 43. Concepts in the Application Behaviour viewpoint.

Example

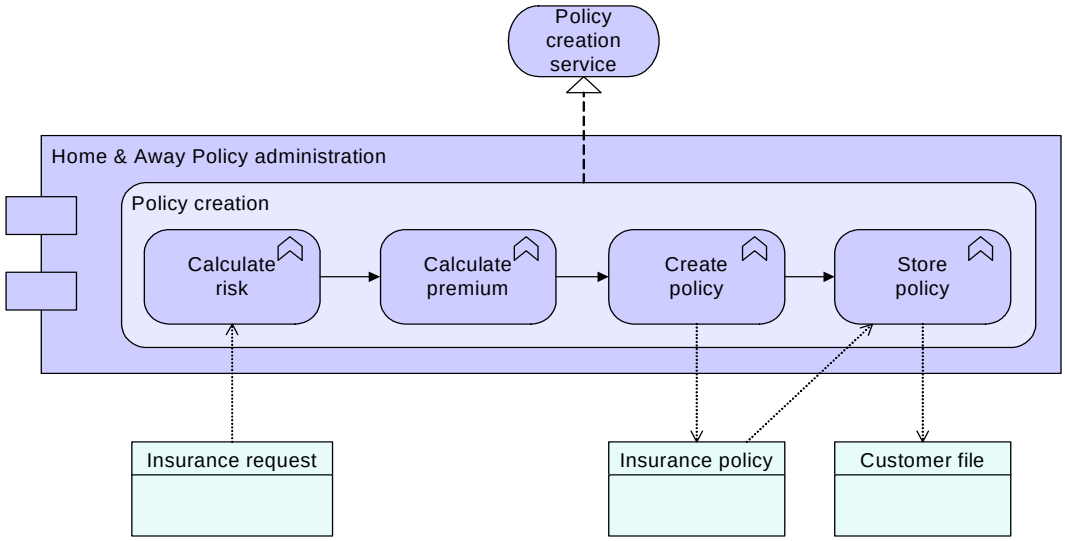


Figure 44. Behaviour of the Home & Away Policy administration in realising the Policy creation service.

5.1.7 Infrastructure Viewpoint

The Infrastructure viewpoint comprises the hardware and software infrastructure upon which the application layer depends. It contains physical devices and networks, and supporting system software such as operating systems, databases and middleware.

Table 10. Infrastructure viewpoint.

VIEWPOINT NAME	Infrastructure
STAKEHOLDERS	Infrastructure architects, (application architects) Operational managers
CONCERNS	Stability, security, dependencies, costs of infrastructure
PURPOSE	Designing
ABSTRACTION LEVEL	Details
LAYERS	Technology
ASPECTS	Behaviour, active

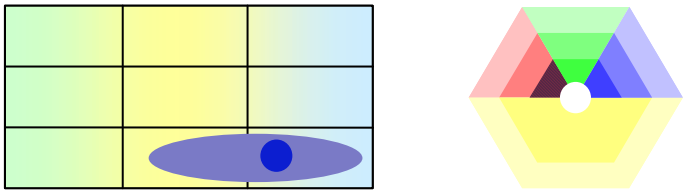


Figure 45. Position of the Infrastructure viewpoint in the conceptual and viewpoint frameworks.

Contents

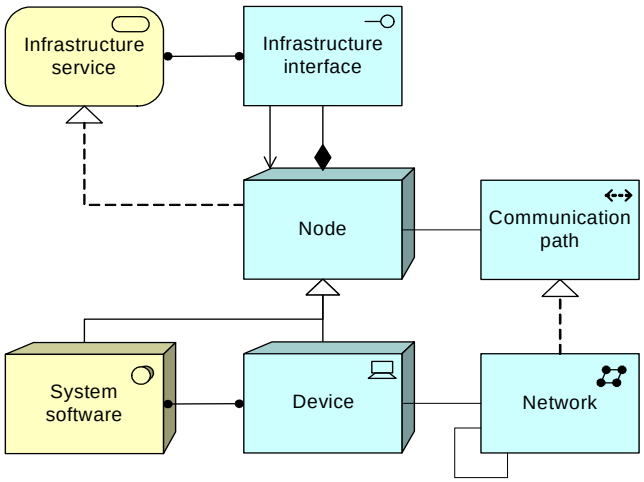


Figure 46. Concepts in the Infrastructure viewpoint.

Example

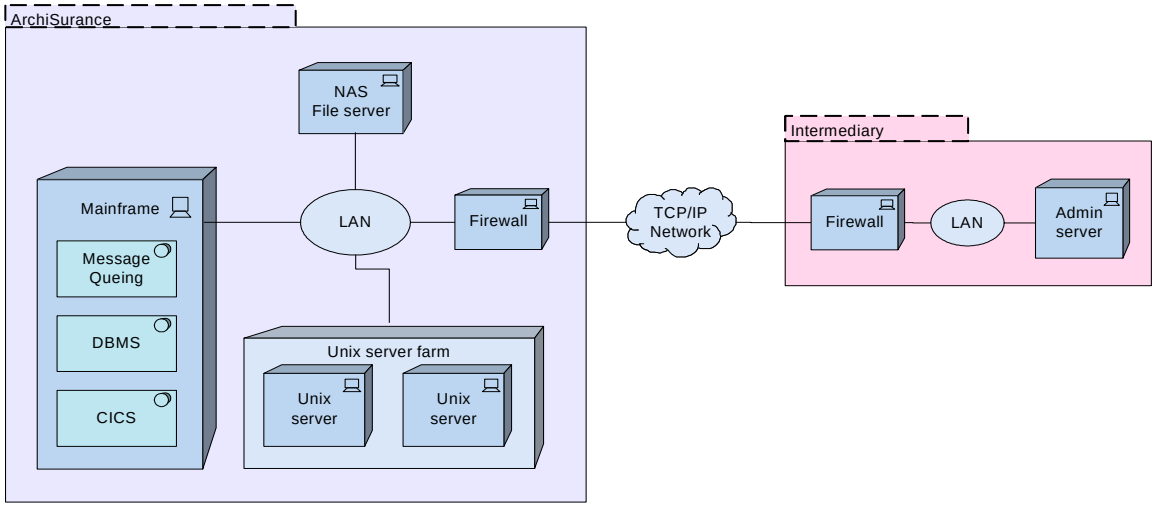


Figure 47. Infrastructure of ArchiSurance.

5.1.8 Actor Cooperation Viewpoint

The Actor Cooperation viewpoint focuses on the relations of actors with each other and their environment. A common example of this is what is sometimes called a ‘context diagram’, which puts an organisation into its environment, consisting of external parties such as customers, suppliers, and other business partners. It is very useful in determining external dependencies and collaborations and shows the value chain or network in which the actor operates.

Another important use of the Actor Cooperation viewpoint is in showing how a number of cooperating (business and/or application) actors together realise a business process, by showing the flow between them. Hence in this viewpoint, both business actors or roles, and application components may occur.

Table 11. Actor Cooperation viewpoint.

VIEWPOINT NAME	Actor Cooperation
STAKEHOLDERS	Enterprise, process, domain architects
CONCERNS	Relations of actors with their environment
PURPOSE	Designing
ABSTRACTION LEVEL	Coherence
LAYERS	Business, (application)
ASPECTS	Structure, behaviour

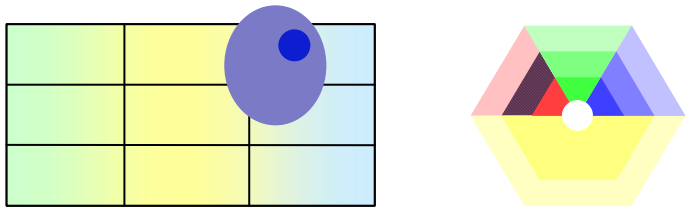


Figure 48. Position of the Actor Cooperation viewpoint in the conceptual and viewpoint frameworks.

Contents

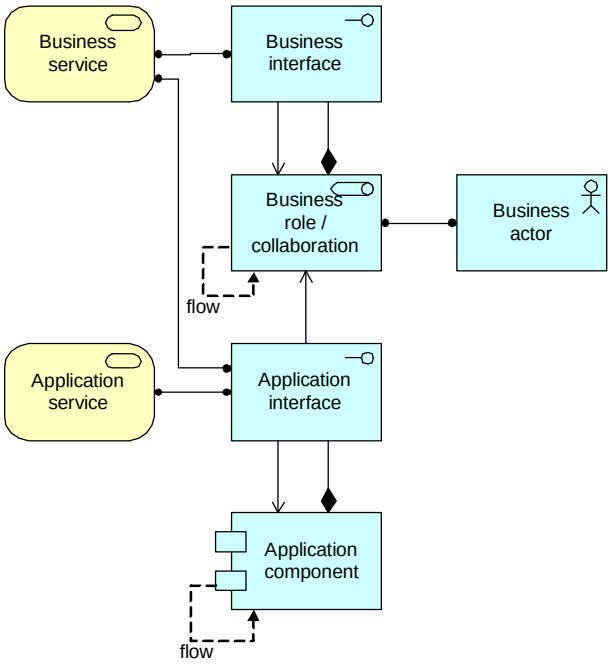


Figure 49. Concepts in the Actor Cooperation viewpoint.

Example

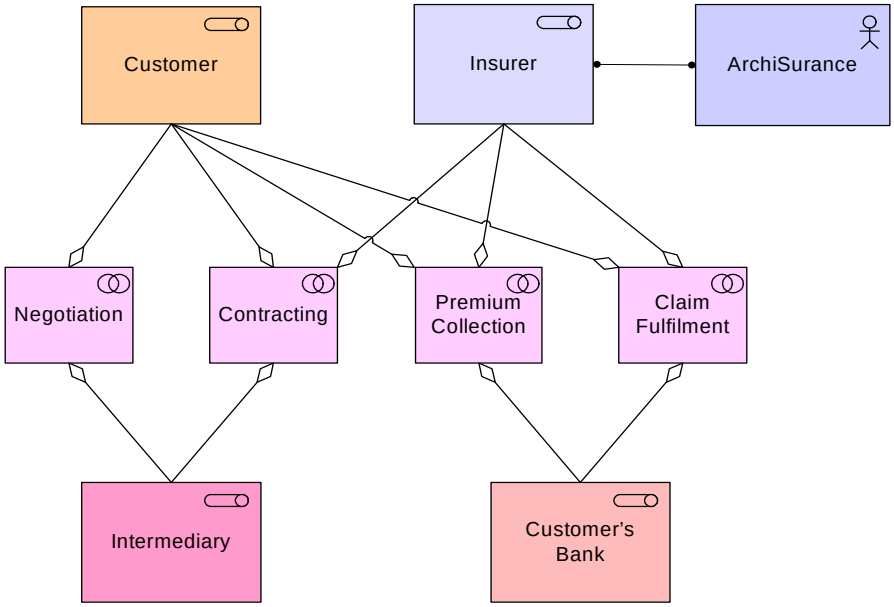


Figure 50. Collaborations of ArchiSurance and its partners.

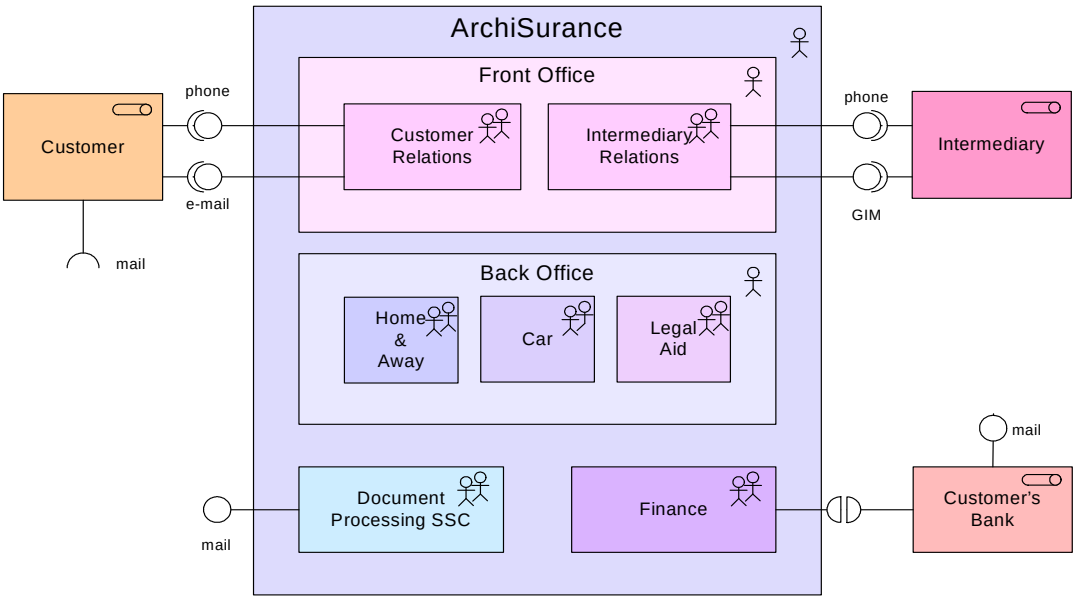


Figure 51. Context and communication of ArchiSurance's departments.

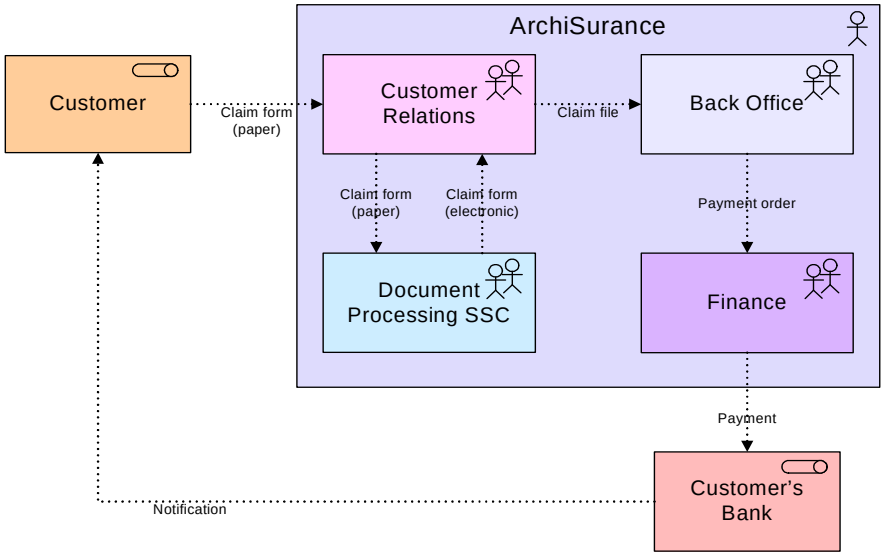


Figure 52. Information flow between ArchiSurance's departments and partners in handling insurance claims.

5.1.9 Business Process Cooperation Viewpoint

The Business Process Cooperation viewpoint is used to show the relations of one or more business processes with each other and/or their surroundings. It can both be used to create a high-level design of business processes within their context and to provide an operational manager responsible for one or more such processes with insight in their dependencies. Important aspects of Cooperation are:

- causal relations between the main business processes of the enterprise;
- the mapping of business processes onto business functions;
- realisation of services by business processes;
- the use of shared data;
- the execution of a business process by the same roles or actors.

Each of these can be regarded as a 'sub-viewpoint' of the Business Process Cooperation viewpoint. Below, we give examples of some of the resulting views.

Table 12. Business Process Cooperation viewpoint.

VIEWPOINT NAME	Business Process Cooperation
STAKEHOLDERS	Process, domain architects Operational managers
CONCERNS	Dependencies of business processes Consistency & completeness Responsibilities
PURPOSE	Designing, deciding
ABSTRACTION LEVEL	Coherence
LAYERS	Business, (application)
ASPECTS	Behaviour, (active), (passive)

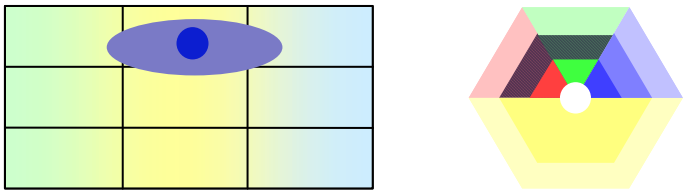


Figure 53. Position of the Business Process Cooperation viewpoint in the conceptual and viewpoint frameworks.

Contents

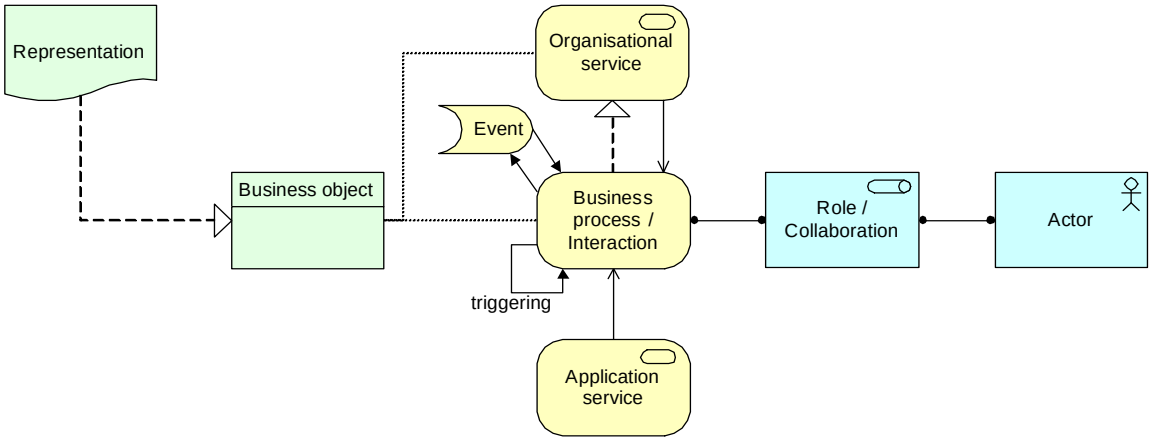


Figure 54. Concepts in the Business Process Cooperation viewpoint.

Example

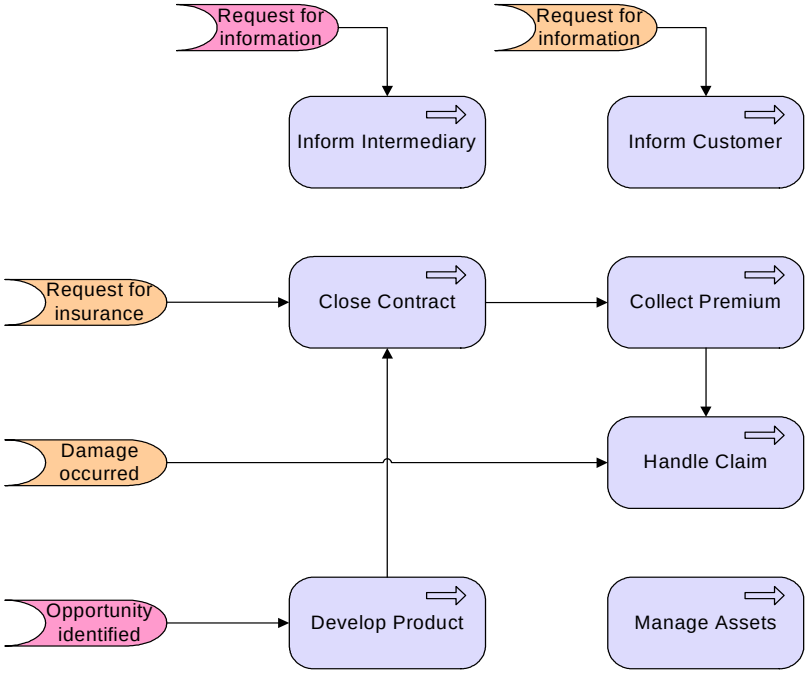


Figure 55. Some of the main business processes, triggers and relations of ArchiSurance.

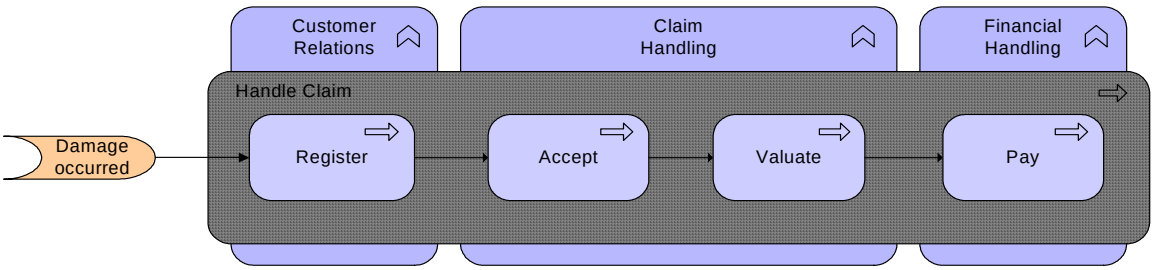


Figure 56. The Handle Claim business process mapped onto the business functions.

5.1.10 Application Cooperation Viewpoint

The Application Cooperation viewpoint shows the relations of a number of applications or components. It describes the dependencies in terms of the information flows between them, or the services they offer and use. This viewpoint is typically used to create an overview of the application landscape of an organisation.

This viewpoint is also used to express the Cooperation or orchestration (i.e., internal Cooperation) of services that together support the execution of a business process. By modelling the interdepencies between services, the Cooperation of the underlying applications is established in a more independent way. If this Cooperation is centralised and internal to the enterprise, we speak of ‘orchestration’; in case of Cooperation between independent entities, the term ‘choreography’ is often used.

Table 13. Application Cooperation viewpoint.

VIEWPOINT NAME	Application Cooperation
STAKEHOLDERS	Enterprise, application, domain architects
CONCERNS	Relations and dependencies of applications Choreography of services Consistency & completeness Reduction of complexity
PURPOSE	Designing
ABSTRACTION LEVEL	Coherence, details
LAYERS	Application
ASPECTS	Active, behaviour

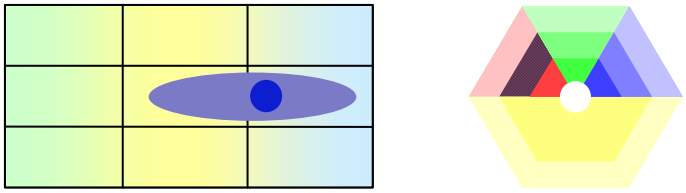


Figure 57. Position of the Application Cooperation viewpoint in the conceptual and viewpoint frameworks.

Contents

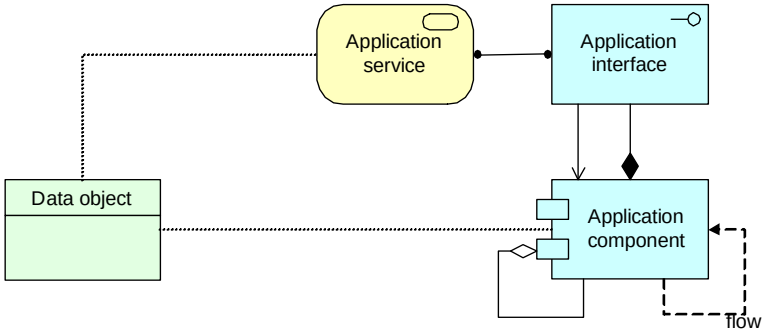


Figure 58. Concepts in the Application Cooperation viewpoint.

Example

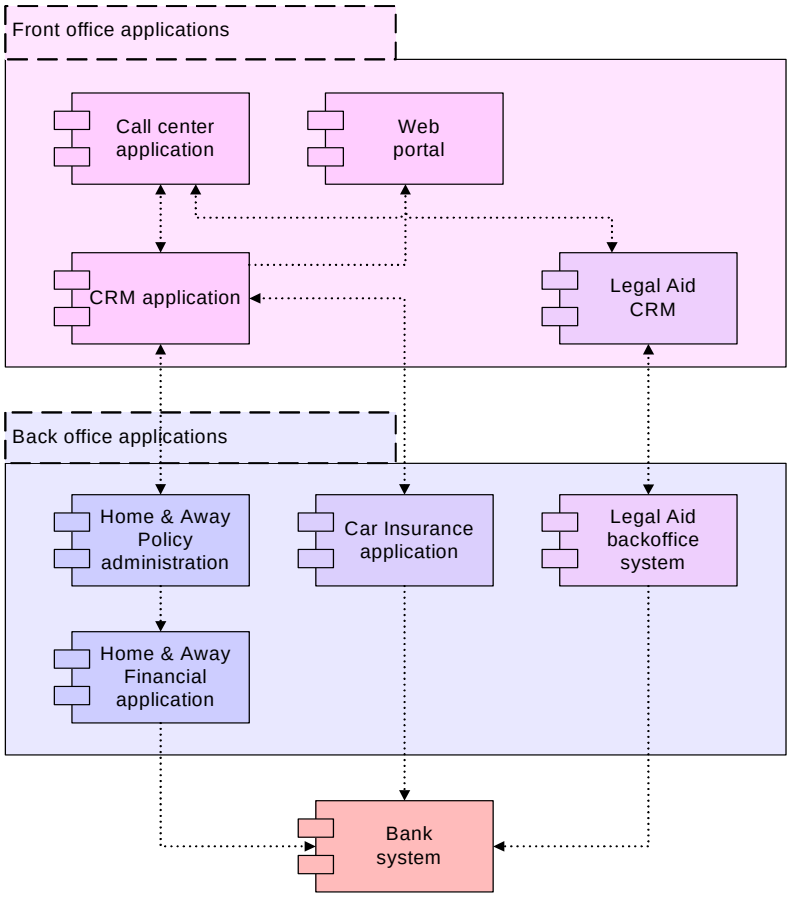


Figure 59. Main applications and information flow of ArchiSurance.

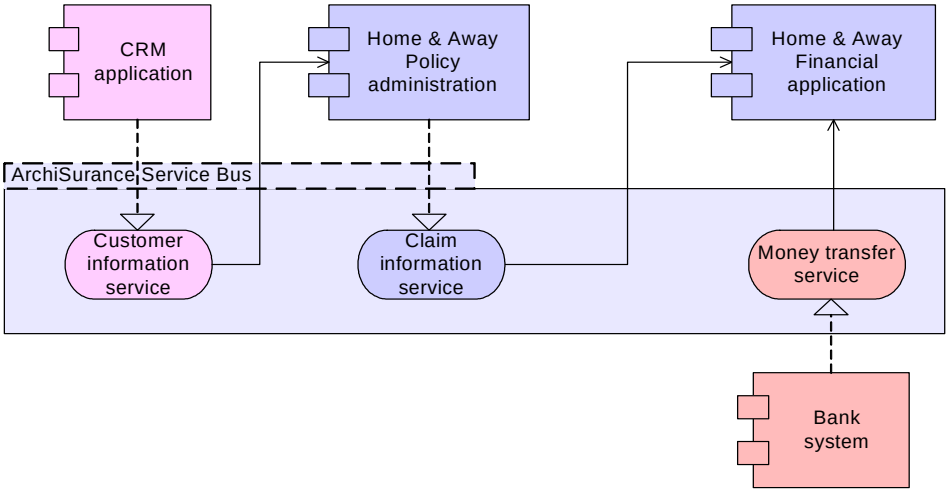


Figure 60. Applications connected through services.

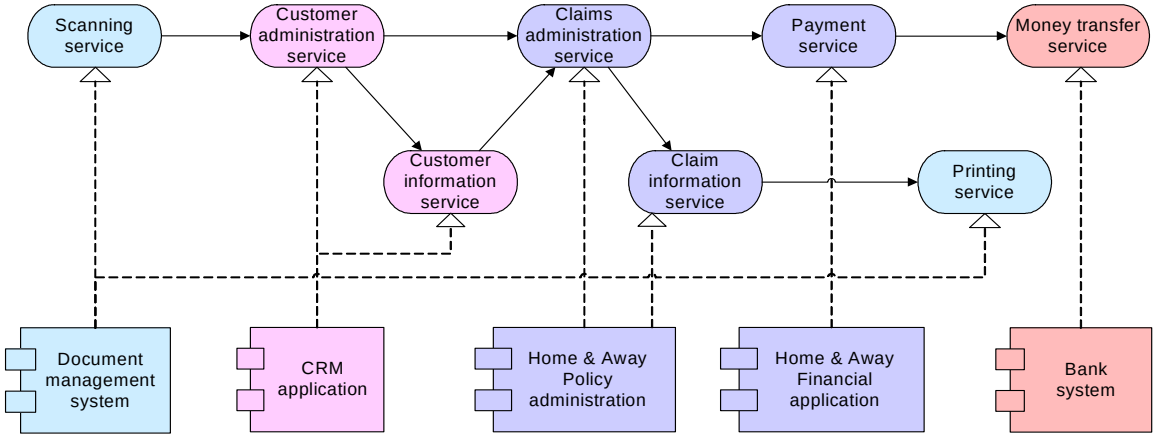


Figure 61. Application service orchestration in processing insurance claims.

5.1.11 Product Viewpoint

The Product viewpoint depicts the value this product offers to the customers or other external parties involved and shows the composition of one or more products in terms of the constituting (business or application) services, and the associated contract(s) or other agreements. It may also be used to show the interfaces (channels) through which this product is offered, and the events associated with the product.

A Product view is typically used in product development to design a product by composing existing services or by identifying which new services have to be created for this product, given the value a customer expects from it. It may then serve as input for business process architects and others that need to design the processes and ICT that realises this product.

Table 14. Product viewpoint.

VIEWPOINT NAME	Product
STAKEHOLDERS	Product developers Product managers Process, domain architects
CONCERNS	Product development Value offered by the products of the enterprise
PURPOSE	Designing, deciding
ABSTRACTION LEVEL	Coherence
LAYERS	Business, (application)
ASPECTS	Behaviour, information, (active)

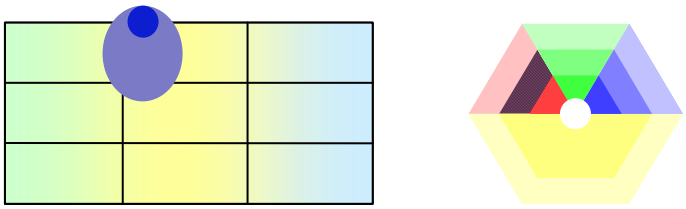


Figure 62. Position of the Product viewpoint in the conceptual and viewpoint frameworks.

Contents

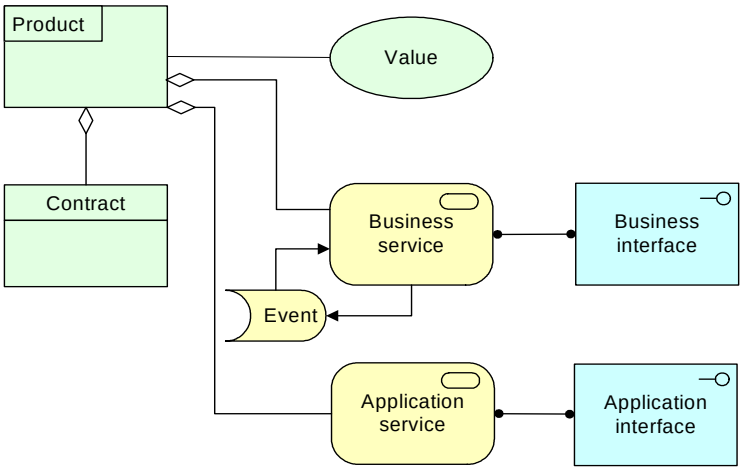


Figure 63. Concepts in the Product viewpoint.

Example

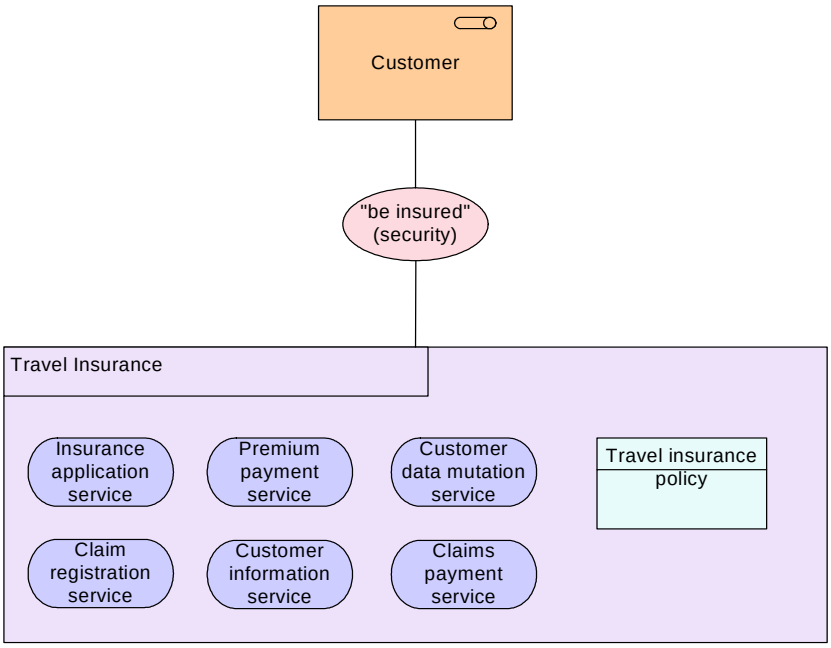


Figure 64. The travel insurance product.

5.1.12 Application Usage Viewpoint

The Application Usage viewpoint describes how applications are used to support one or more business processes, and how they are used by other applications. It can be used in designing an application by identifying the services needed by business processes and other applications, or in designing business processes by describing the services that are available. Furthermore, since it identifies the depedencies of business processes upon applications, it may be useful to operational managers responsible for these processes.

Table 15. Application Usage viewpoint.

VIEWPOINT NAME	Application Usage
STAKEHOLDERS	Enterprise, process, application architects Operational managers
CONCERNS	Consistency & completeness Reduction of complexity
PURPOSE	Designing, deciding
ABSTRACTION LEVEL	Coherence
LAYERS	Business, application
ASPECTS	Behaviour, active, (passive)

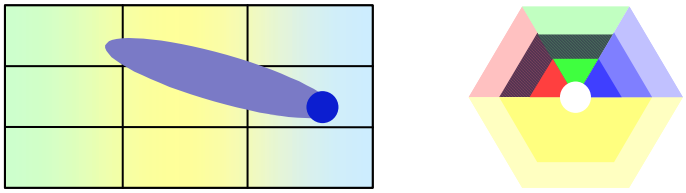


Figure 65. Position of the Application Usage viewpoint in the conceptual and viewpoint frameworks.

Contents

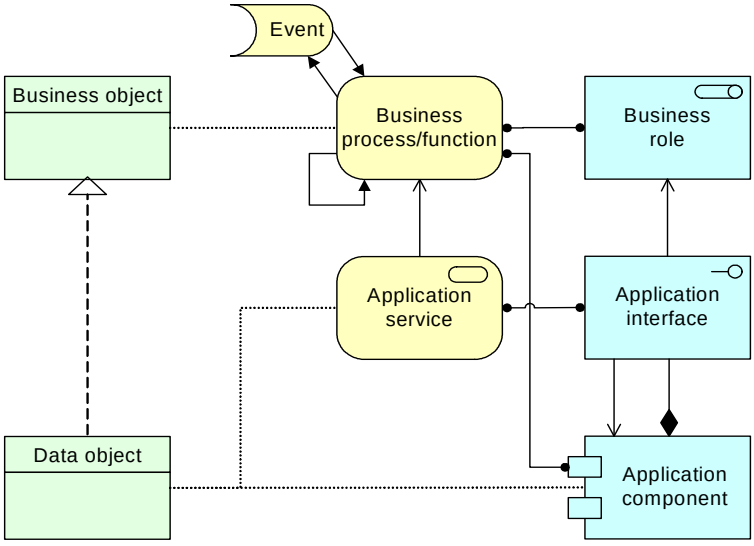


Figure 66. Concepts in the Application Usage viewpoint.

Example

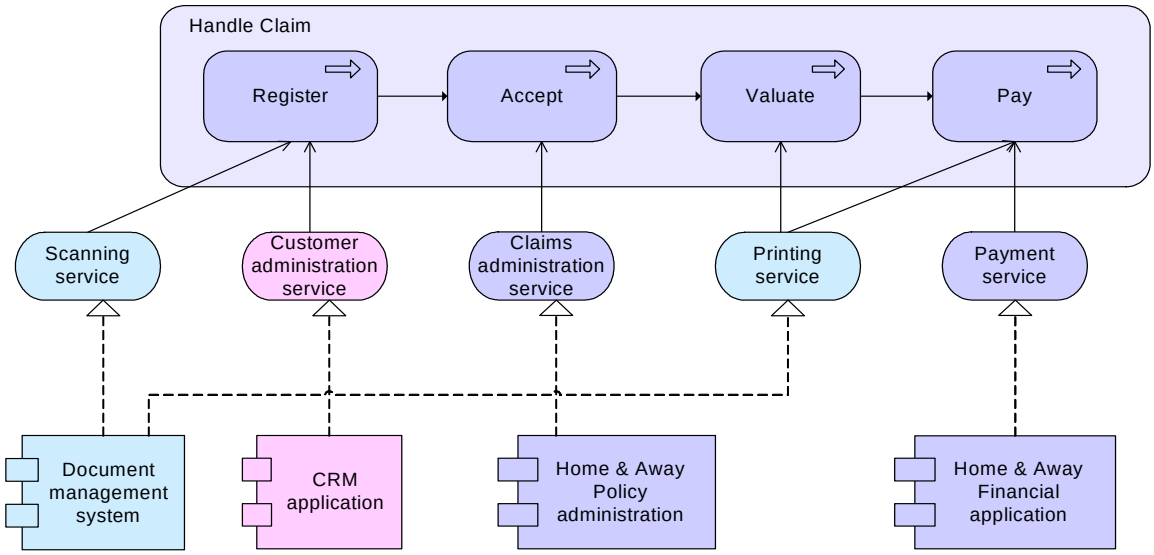


Figure 67. Application usage by the Handle Claim business process.

5.1.13 Infrastructure Usage Viewpoint

The Infrastructure Usage viewpoint shows how applications are supported by the software and hardware infrastructure: the infrastructure services delivered by the devices, system software and networks are provided to the applications.

This viewpoint plays an important role in the analysis of performance and scalability, since it relate the physical infrastructure to the logical world of applications. It is very useful in determining the performance and quality requirements on the infrastructure based on the demands of the various applications that use it.

Table 16. Infrastructure Usage viewpoint.

VIEWPOINT NAME	Infrastructure Usage
STAKEHOLDERS	Application, infrastructure architects Operational managers
CONCERNS	Dependencies, performance, scalability
PURPOSE	Designing
ABSTRACTION LEVEL	Coherence
LAYERS	Application, technology
ASPECTS	Active, (behaviour)

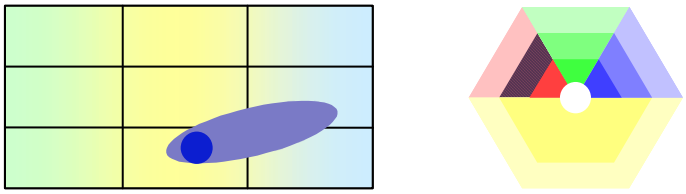


Figure 68. Position of the Infrastructure Usage viewpoint in the conceptual and viewpoint frameworks.

Contents

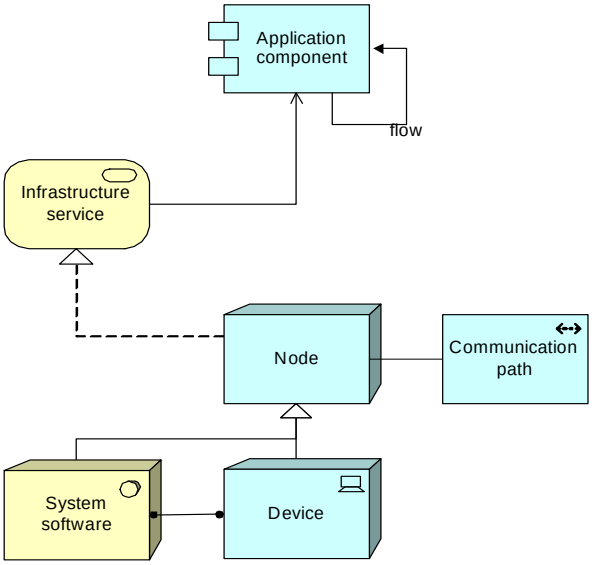


Figure 69. Concepts in the Infrastructure Usage viewpoint.

Example

An example of this viewpoint is given in Figure. 70, which shows the use, by a number of back-office applications, of the messaging and data access services offered by ArchiSurance's infrastructure.

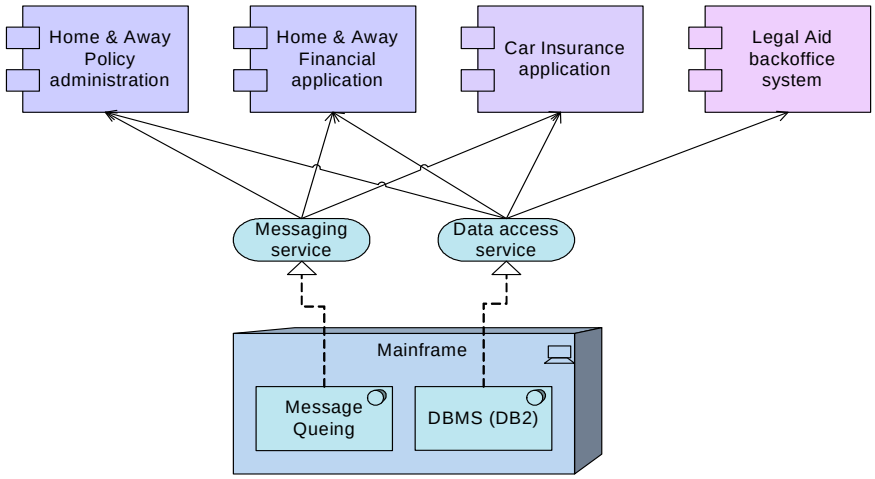


Figure. 70. Use of infrastructure services by ArchiSurance's back-office applications.

5.1.14 Service Realisation Viewpoint

The Service Realisation viewpoint is used to show how one or more business services are realised by the underlying processes (and sometimes by application components). Thus, it forms the bridge between the Product viewpoint and the Business Process viewpoint. It provides a 'view from the outside' on one or more business processes.

Table 17. Service Realisation viewpoint.

VIEWPOINT NAME	Service Realisation
STAKEHOLDERS	Process, domain architects Product & operational managers
CONCERNS	Added value of business processes Consistency & completeness Responsibilities
PURPOSE	Designing, deciding
ABSTRACTION LEVEL	Coherence
LAYERS	Business, (application)
ASPECTS	Behaviour, (active), (passive)

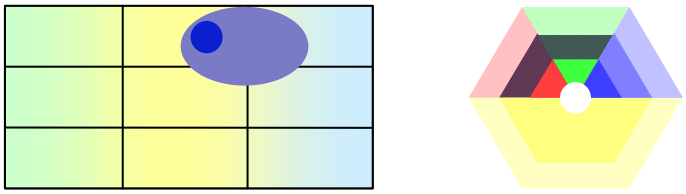


Figure 71. Position of the Service Realisation viewpoint in the conceptual and viewpoint frameworks.

Contents

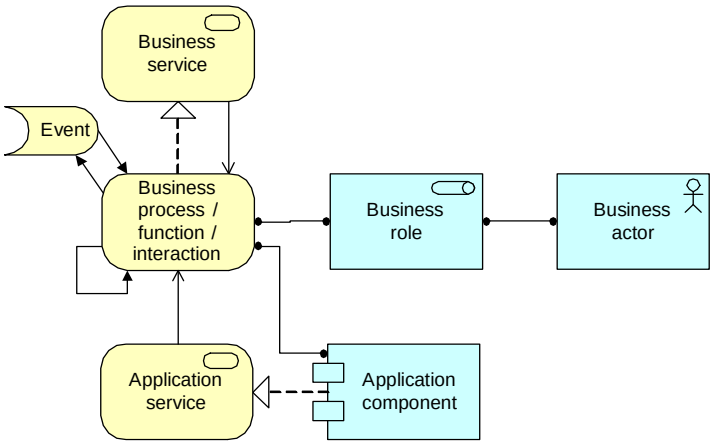


Figure 72. Concepts in the Service Realisation viewpoint.

Example

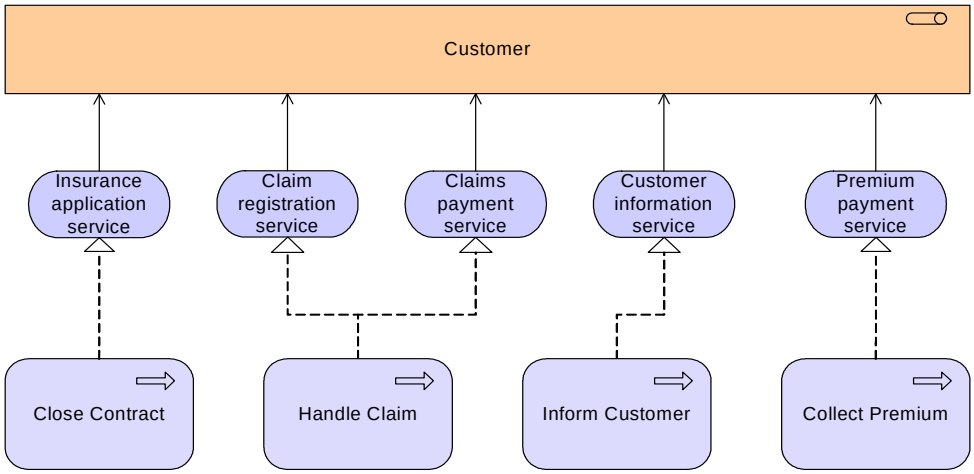


Figure 73. Realisation of services by main ArchiSurance business processes.

5.1.15 Implementation & Deployment Viewpoint

The Implementation & Deployment viewpoint shows how one or more applications are realised on the infrastructure. This comprises the mapping of (logical) applications and components onto (physical) artifacts like e.g. Enterprise Java Beans, and the mapping of the information used by these applications and components onto the underlying storage infrastructure, e.g. database tables or other files.

Deployment views play an important role in the analysis of performance and scalability, since they relate the physical infrastructure to the logical world of applications. In security and risk analysis, Deployment views are used to identify e.g. critical dependencies and risks.

Table 18. Implementation & Deployment viewpoint.

VIEWPOINT NAME	Implementation & Deployment
STAKEHOLDERS	Application, infrastructure architects Operational managers
CONCERNS	Dependencies, security, risks
PURPOSE	Designing
ABSTRACTION LEVEL	Coherence
LAYERS	Application, technology
ASPECTS	Active, (behaviour)

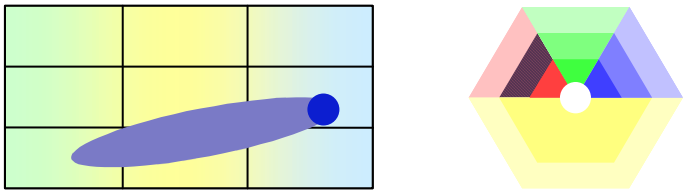


Figure 74. Position of the Implementation & Deployment viewpoint in the conceptual and viewpoint frameworks.

Contents

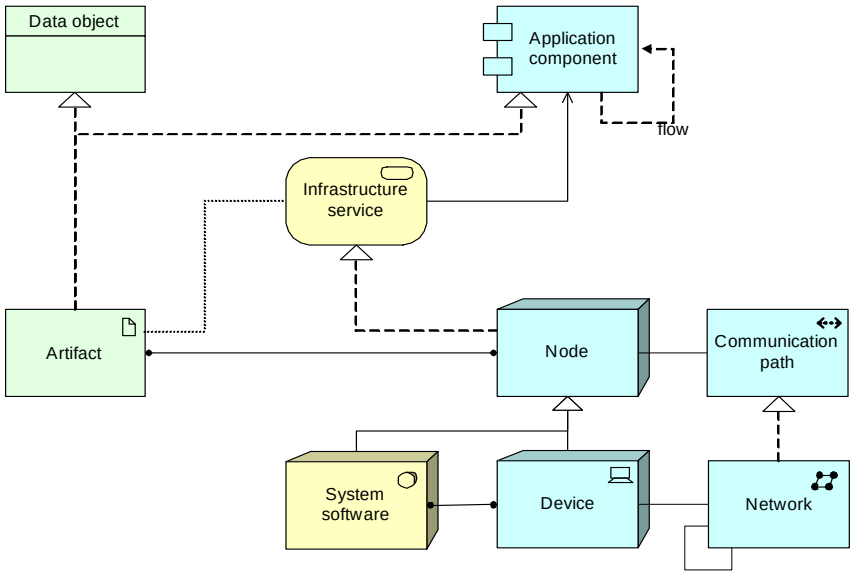


Figure 75. Concepts in the Implementation & Deployment viewpoint.

Example

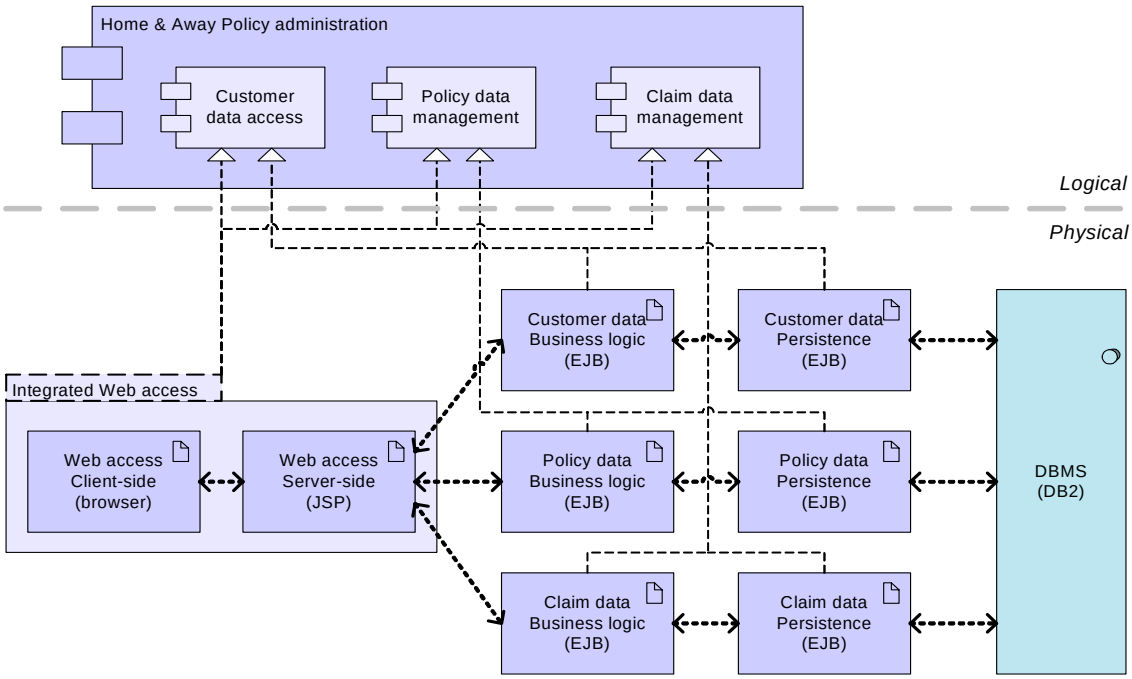


Figure 76. Mapping of logical application components of the ArchiSurance policy administration onto phyisical artifacts.

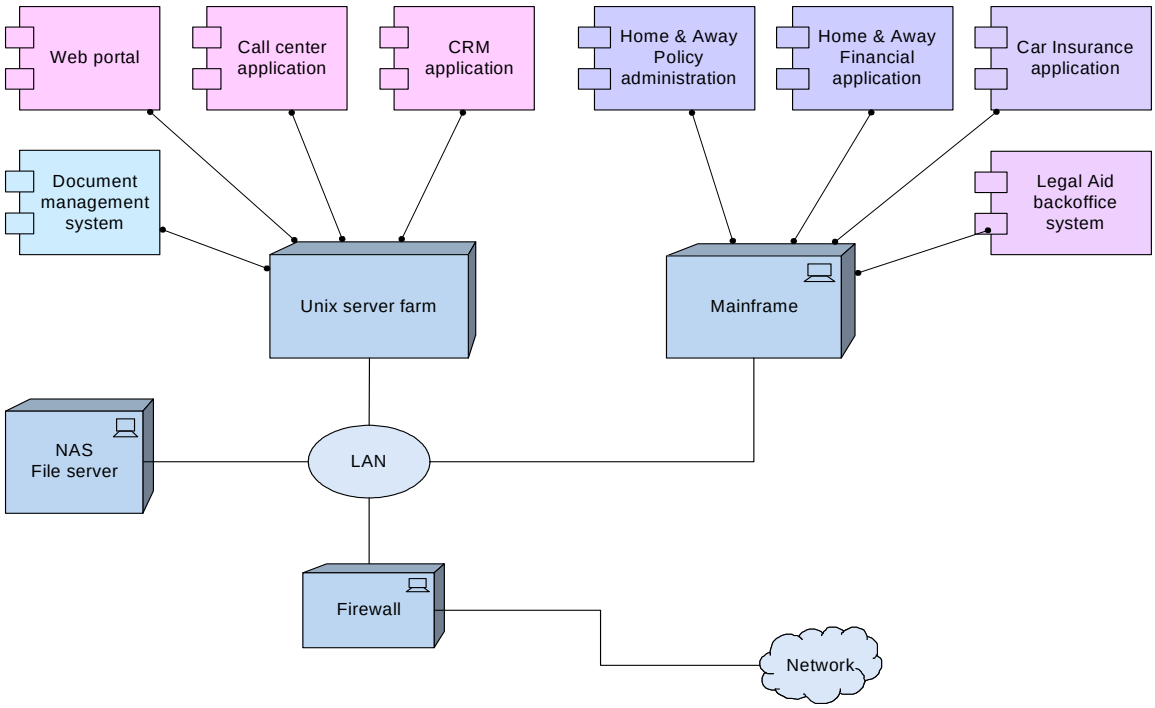


Figure 77. Deployment of ArchiSurance's main applications onto its infrastructure.

5.2 Layered Viewpoint

The layered viewpoint shows multiple layers and multiple aspects in one diagram. The main purpose of this viewpoint is to provide an overview of a part of business architecture in a single picture. Furthermore, it can be used for impact-of-change or performance analysis and for extending the business with new services.

Typical stakeholders of the layered viewpoint are (enterprise) architects, but also operational managers that are responsible for business processes, application or IT services.

Table 19. Layered viewpoint.

VIEWPOINT NAME	Layered viewpoint
STAKEHOLDERS	Enterprise, application, process, infrastructure, domain architects
CONCERNS	Consistency Reduction of complexity Impact of change Flexibility
PURPOSE	Designing
ABSTRACTION LEVEL	Overview
LAYERS	Business, application, technology
ASPECTS	Active, behaviour, passive

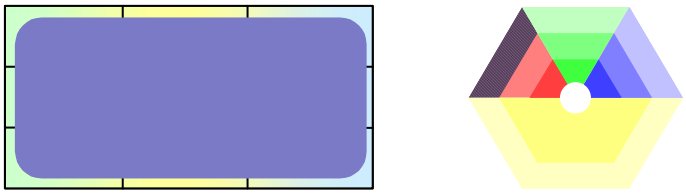


Figure 78. Position of the Layered viewpoint in the conceptual and viewpoint frameworks.

5.2.1 Contents

Below we discuss a number of characteristics of this layering approach that are of particular importance not only for the visualisation of architecture viewpoints but also for other purposes, such as the quantification of relations and architecture elements and the subsequent performance analysis or impact of change analysis of architecture models.

There are two categories of layers, namely dedicated layers and service layers. The layers are the result of the use of the “grouping” relation for a partitioning of the entire set of objects and relations that belong to a model. The infrastructure, the application, the (application and business) function, the process and the actors/roles layers belong to the first category. The structural principle behind a fully layered view is that each dedicated layer exposes, by means of the “realisation” relation a layer of services, which are further on “used by” the next dedicated layer. Thus we can easily separate the internal structure and

organisation of a dedicated layer from its externally observable behaviour expressed as the service layer that the dedicated layer realises. The order, number, or nature of these layers are not fixed, but in general a (more or less) complete and natural layering of an ArchiMate model will contain the succession of layers depicted in Figure 79.

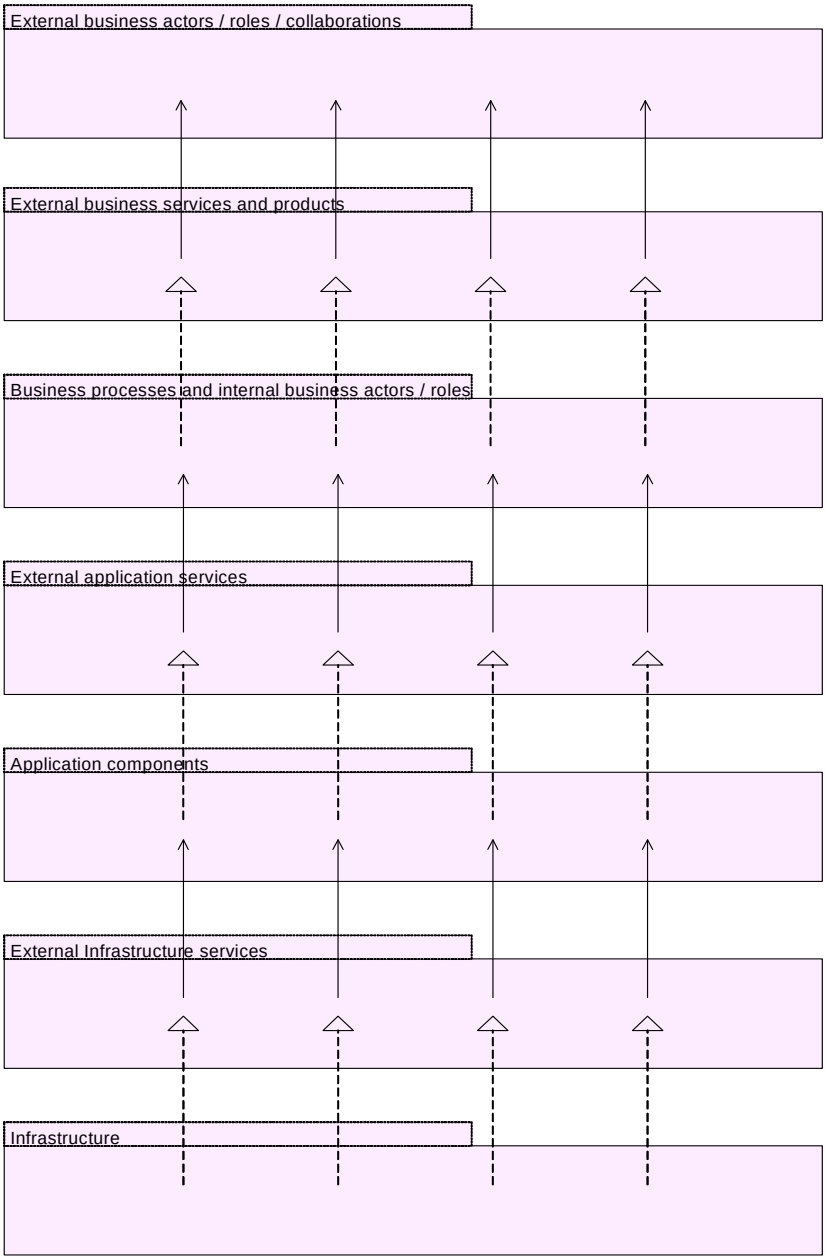


Figure 79. Layers of ArchiMate models.

With respect to the dedicated layers, the ArchiMate concepts are clustered according to the business, application, and technology layers of the framework of Figure 15. The service layers in between contain the corresponding business, application, resp. technology services.

This layered view on ArchiMate models has the following immediate consequences:

- Any model is a hierarchy, which in terms of graph theory can be described as an acyclic directed graph, having one or more sources, typically lying in the infrastructure layer and one or more sinks, typically lying in the External business actors/roles layer. A source is an object, in which no incoming arcs enter. A sink is an object from which no outgoing arcs leave.
- Any relation between different layers is either “used by” or “realises” or sometimes “assigned to”.
- Any connector having the ends in two consecutive layers is the depiction of either a “realises” relation or a “used by” relation.
- In general, each vertical path, for instance from a source to a sink, consists of an alternating sequence of “realise” and “used by” arcs.

5.2.2 Example

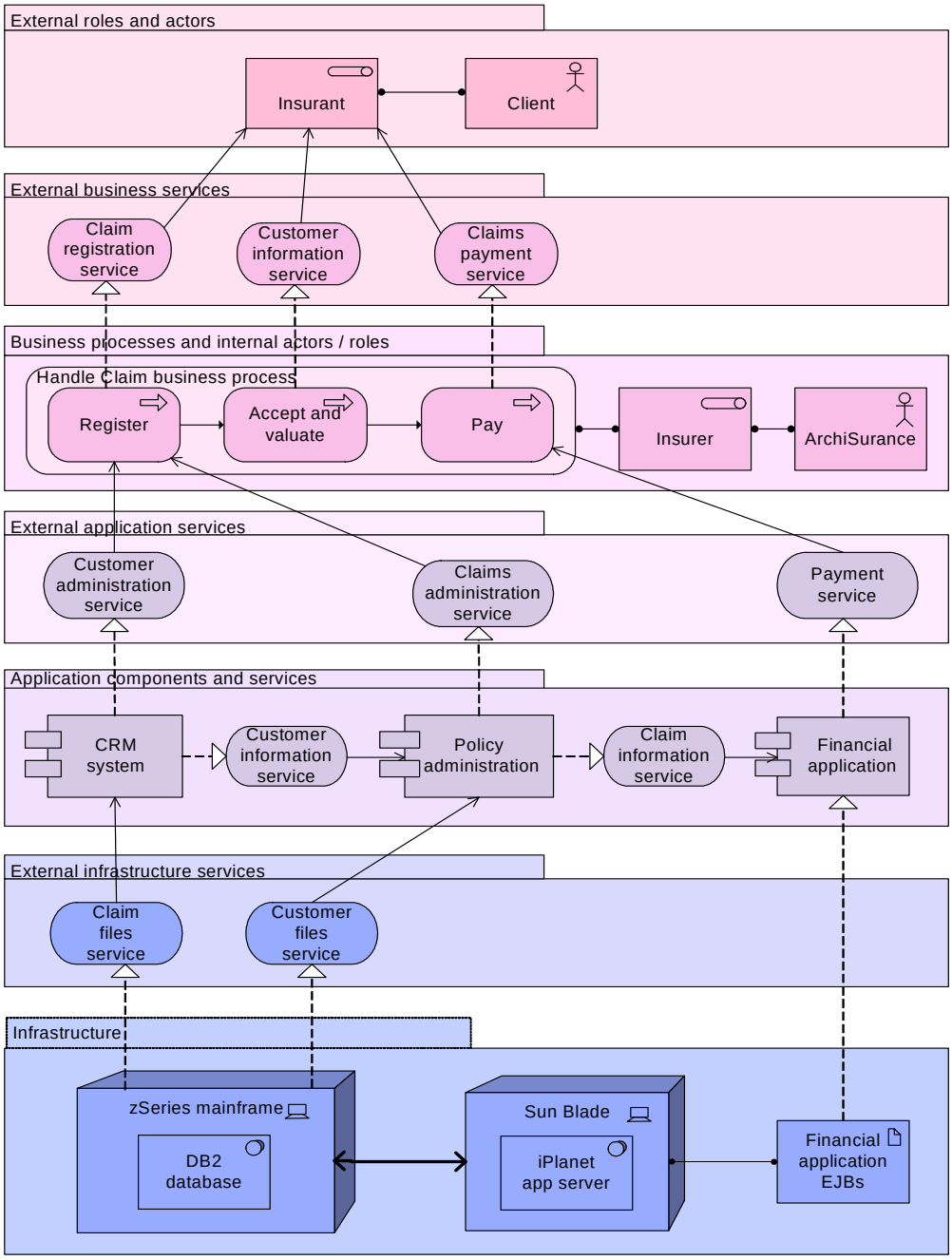


Figure 80. Example of a layered view.

The example given in Figure 80 covers a number of layers from business to infrastructure. The example is centered around a single business process, the Handle Claim process. Alternatively, a layered view could, for example, focus on a single application and all related infrastructure, business processes, etc., or on a single business service and all layers contributing to the realisation of that service.

The layered view of ArchiMate models is a very powerful instrument, which provides the user with more than just a viewpoint. It is easy to see that the usage of layering is beneficial at least for the following reasons:

- It gives a clear structure to models.
- It reduces the complexity of diagrams.
- It creates a style of architecting and designing.
- Although structured, it offers a certain degree of flexibility, since the number, and nature of the layers is not fixed. One can abstract from those layers that are not relevant for the problem under investigation. The order of the dedicated layers in a layered view, however, has to be compliant with the metamodel of the ArchiMate language. More precisely, the order in which two dedicated layers occur is dependant on the existence in the metamodel of a directed path between the types of concepts that are typically used in the two layers. For example the application layer cannot be placed on top of the process layer because no directed path, for instance, from a process to an application component can be found in the metamodel of the ArchiMate language. The reverse order is, obviously, possible.
- It is an excellent approach when an overview of complex structures is needed. Nevertheless, it allows the designer to create models at any level of detail, since each layer can be as complex as necessary.
- The layered view can be fully or partially used: one may create models that are only partially layered (for an example see Figure 88 and Figure 89).

5.3 Introductory Viewpoint

The Introductory viewpoint forms a subset of the full ArchiMate language using a simplified notation. It is typically used at the start of a design trajectory, when not everything needs to be detailed out yet, or to explain the essence of an architecture model to non-architects that require a simpler notation.

Another use of this basic, less formal viewpoint is that it tries to avoid the impression that the architectural design is already fixed, an idea that may easily arise when using a more formal, highly structured or detailed visualisation.

Table 20. Introductory viewpoint.

VIEWPOINT NAME	Introductory viewpoint
STAKEHOLDERS	(Enterprise) architects Managers
CONCERNS	Early design choices High-level overview
PURPOSE	Design, inform
ABSTRACTION LEVEL	Coherence, overview
LAYERS	Business, application, technology
ASPECTS	Active, behaviour, passive

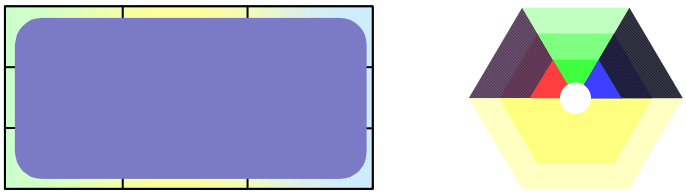


Figure 81. Position of the Introductory viewpoint in the conceptual and viewpoint frameworks.

5.3.1 Contents

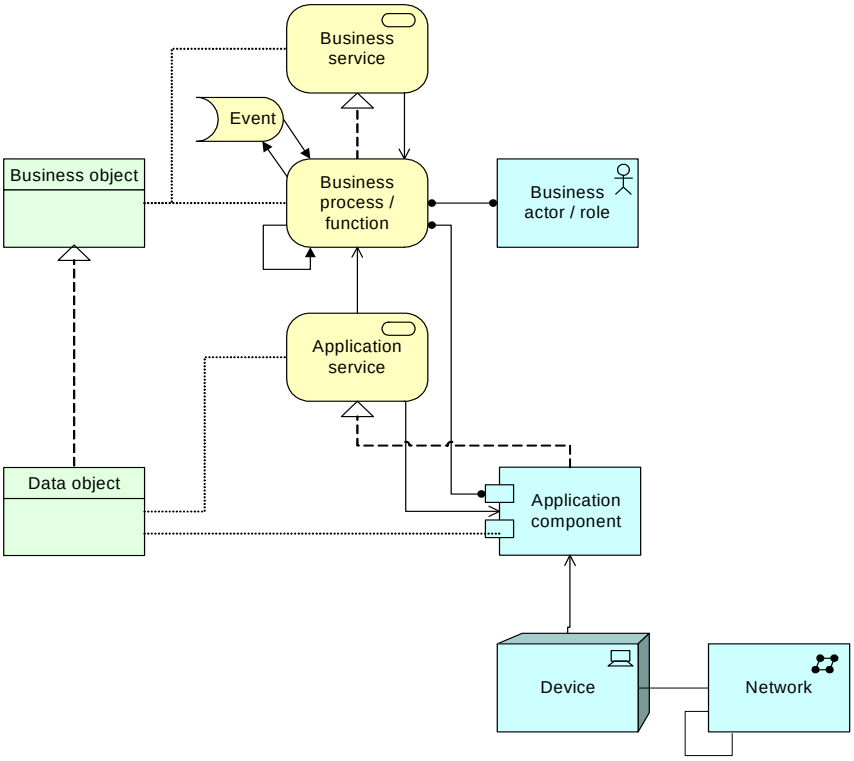


Figure 82. Concepts in the Introductory viewpoint.

We use a simplified notation for the concepts (Figure 83), and for the relations. All relations except ‘triggering’ and ‘realisation’ are denoted by simple lines; ‘realisation’ has an arrow in the direction of the realised service; ‘triggering’ is also represented by an arrow. The concepts are denoted with slightly thicker lines and rounded corners, which give a less formal impression. The example below illustrates this notation. On purpose, the layout of this example is not as ‘straight’ as an ordinary architecture diagram; this serves to avoid the idea that the design is already fixed.

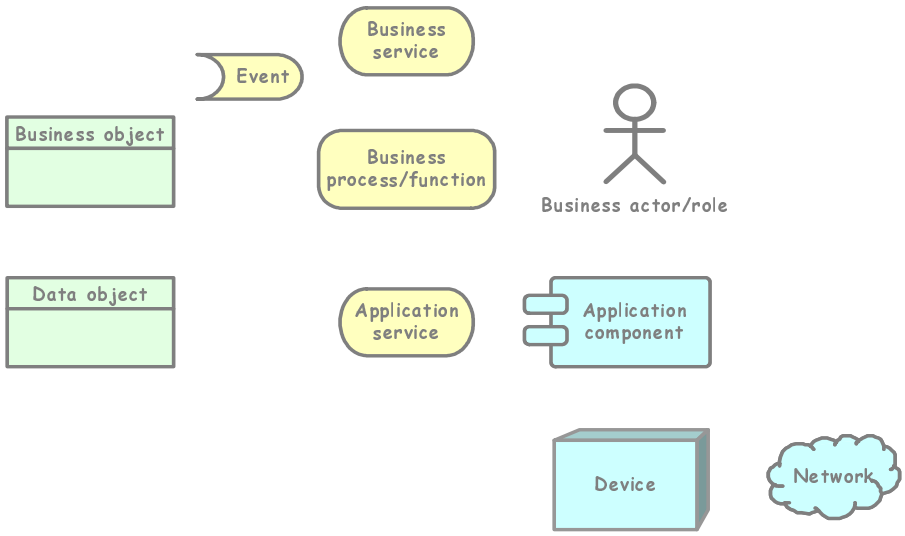


Figure 83. Notation for the Introductory viewpoint.

5.3.2 Example

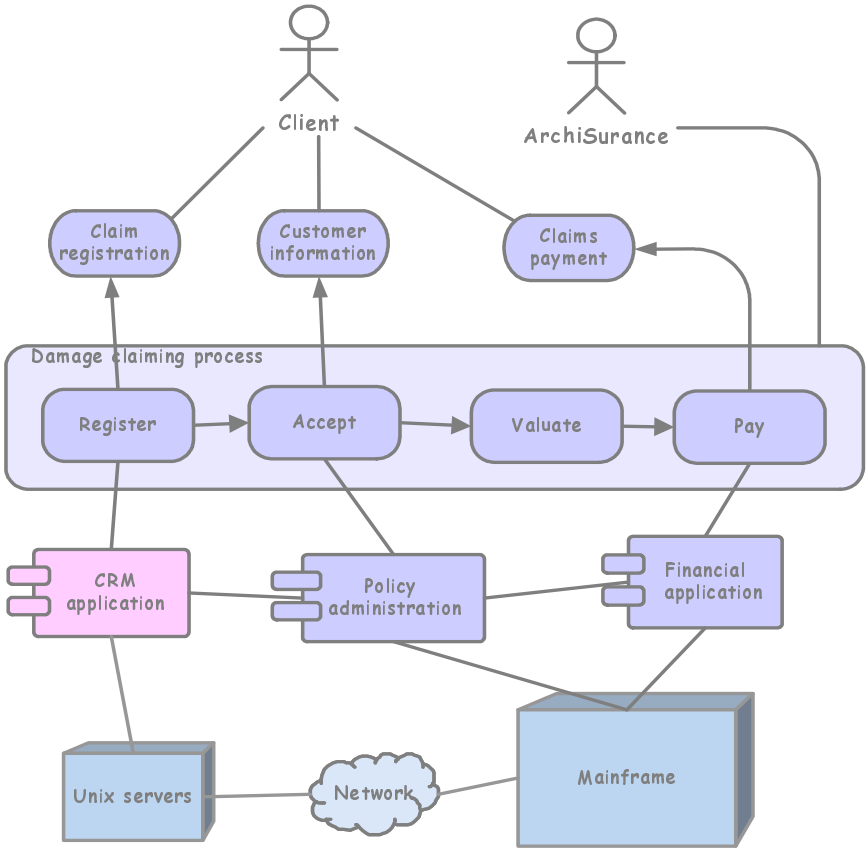


Figure 84. Example of an Introductory view.

5.4 Design Process Viewpoint

The design process viewpoint aims to give insight in the steps taken in the design process, and to visualise these according to the level of certainty or agreement that has been reached about these design choices. Typical stakeholders of the design process viewpoint are (enterprise) architects that need to communicate the status of the design process.

Table 21. Design Process viewpoint.

VIEWPOINT NAME	Design Process viewpoint
STAKEHOLDERS	(Enterprise) architects Managers
CONCERNS	Make design choices visible Convince stakeholders
PURPOSE	Design
ABSTRACTION LEVEL	Details, coherence, overview
LAYERS	Business, application, technology
ASPECTS	Active, behaviour, passive

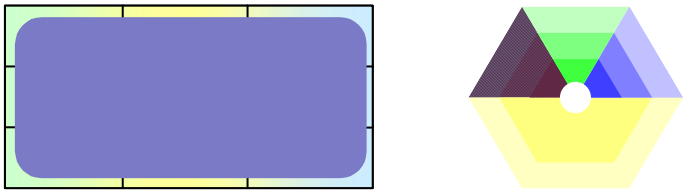


Figure 85. Position of the Design Process viewpoint in the conceptual and viewpoint frameworks.

5.4.1 Contents

To create a design process view, we apply a number of abstraction and presentation rules to a given model. These rules are written down in the form of *production rules* in the form

x ::= *y*

where *y* is replaced by *x* if the rule is applied. Abstraction rules are concerned with changing the contents of the model by omitting or replacing objects. Presentation rules are concerned with the appearance of a model, but do not change its contents.

The rules we use are described in more detail in Appendix A.

5.4.2 Example

Below, we show the operation of the design process viewpoint by means of an example. The starting point is the layered example model given in Section 5.2, Figure 80. This model covers all layers, from business to infrastructure, and it appears quite formal. If we apply the “informalise font”, “informalise shape”, “informalise line”, and “informalise colour” rules shown below, we obtain Figure 86. Note that the contents of this view are identical to Figure 80, but that the appearance suggest a less “fixed” and “formal” model.

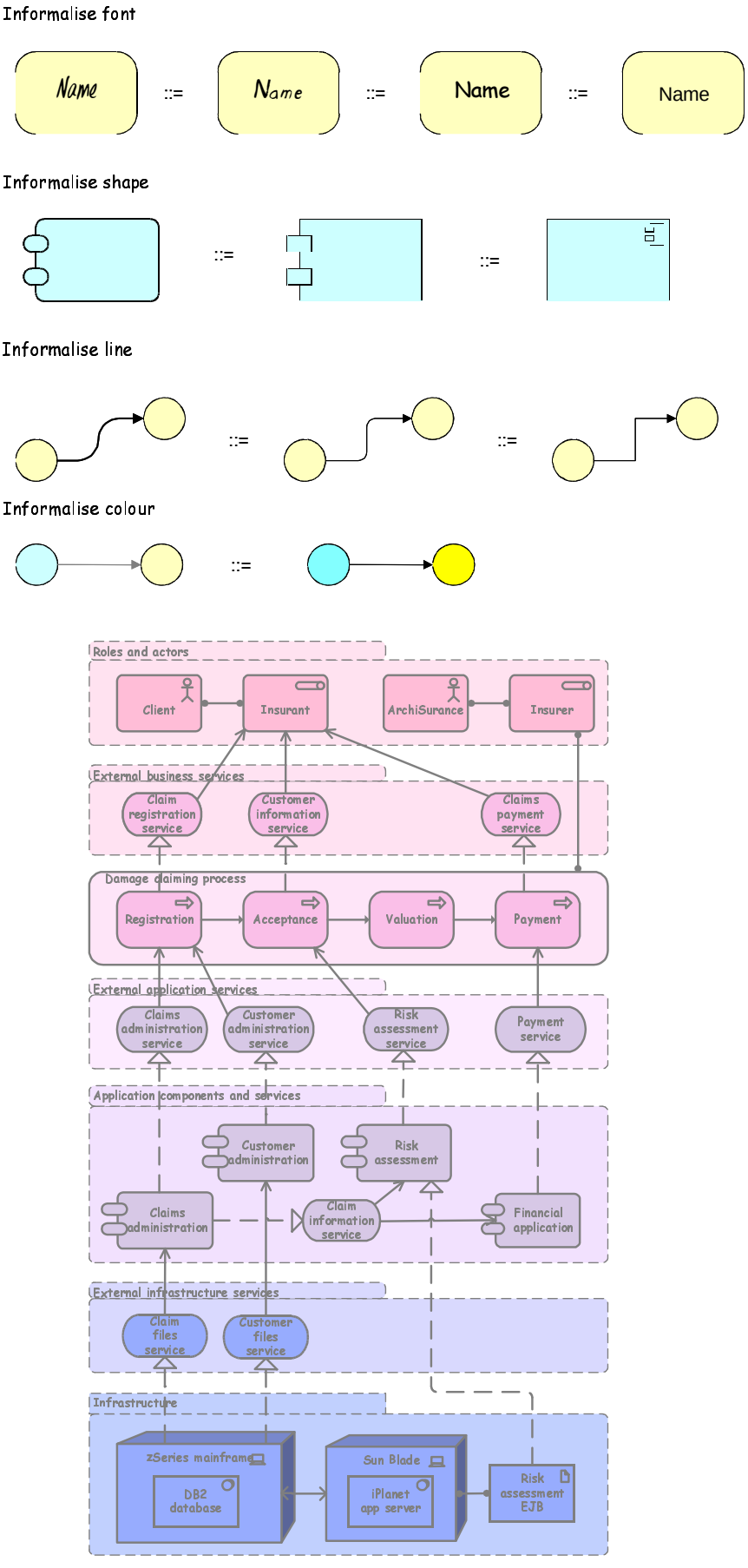


Figure 86. Step 1: Informalised the visualisation.

Next, we apply the “abstract from role” rule (below), and the “informalise shape” rule to the actors and processes. Note that we have also added their purpose, which was not in the previous figures. This results in Figure 87.

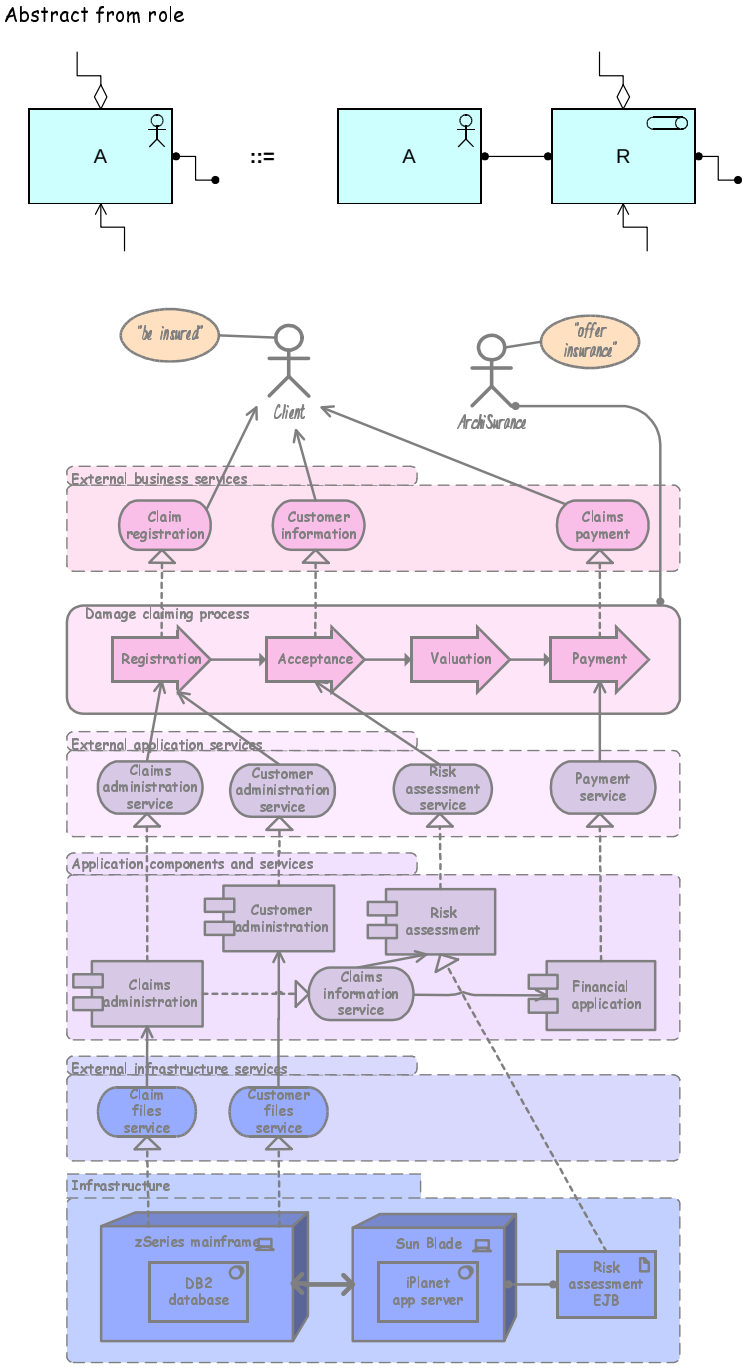
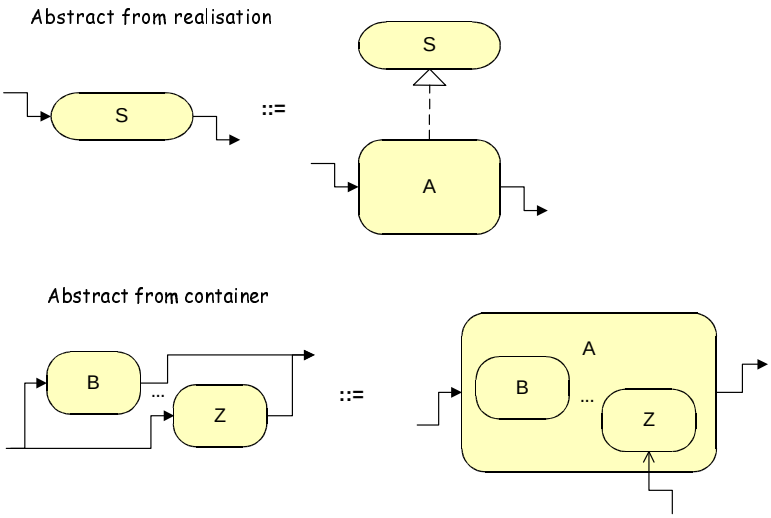


Figure 87. Step 2.

Applying the “abstract from realisation” rule (below) to the artifact shown in Figure 87, “abstract from container” to the bottom three groups (layers) in the model, and “informalise line” to the network between the two devices, results in Figure 88.



These abstraction rules, as opposed to the presentation rules of the previous step, change the contents of the model .”Abstract from realisation” starts with a realisation relation and removes the object at the ‘realising’ end; all relations to this object are moved to the ‘realised’ object. “Abstract from container” operates similarly: it removes the containing object but leaves the contained objects and moves relations from the containing to the contained objects.

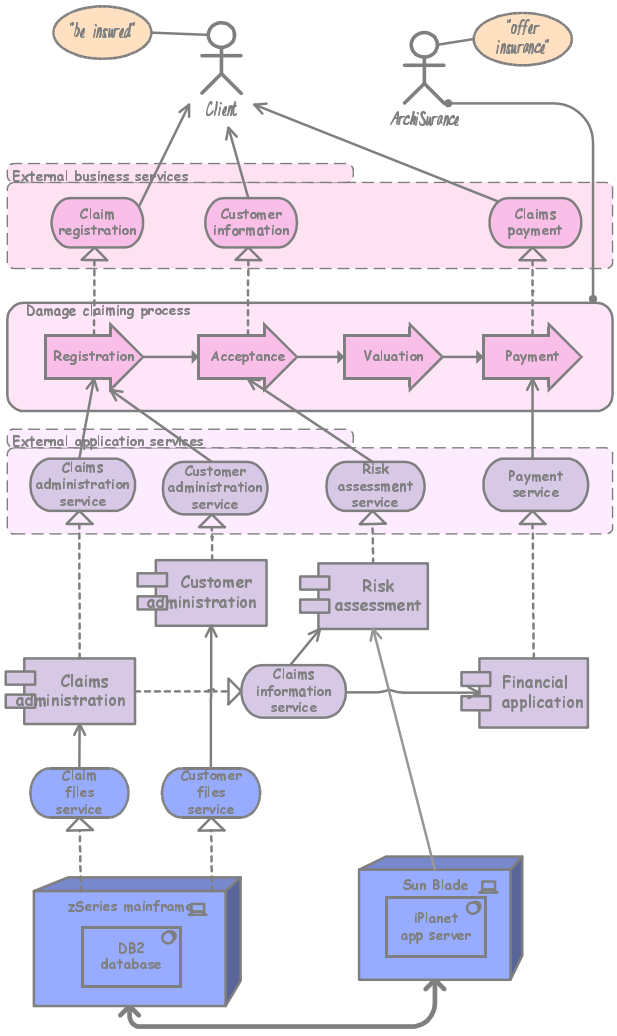


Figure 88. Step 3.

Skipping a few applications of “abstract from container”, we now apply “abstract from service” and “informalise layout”. This results in Figure 89. “Abstract from service” removes services as the intermediary between the ‘user’ and the functionality used. This serves to simplify the look of a model; the use relations formerly connecting the service are now directly linked to the functionality used.

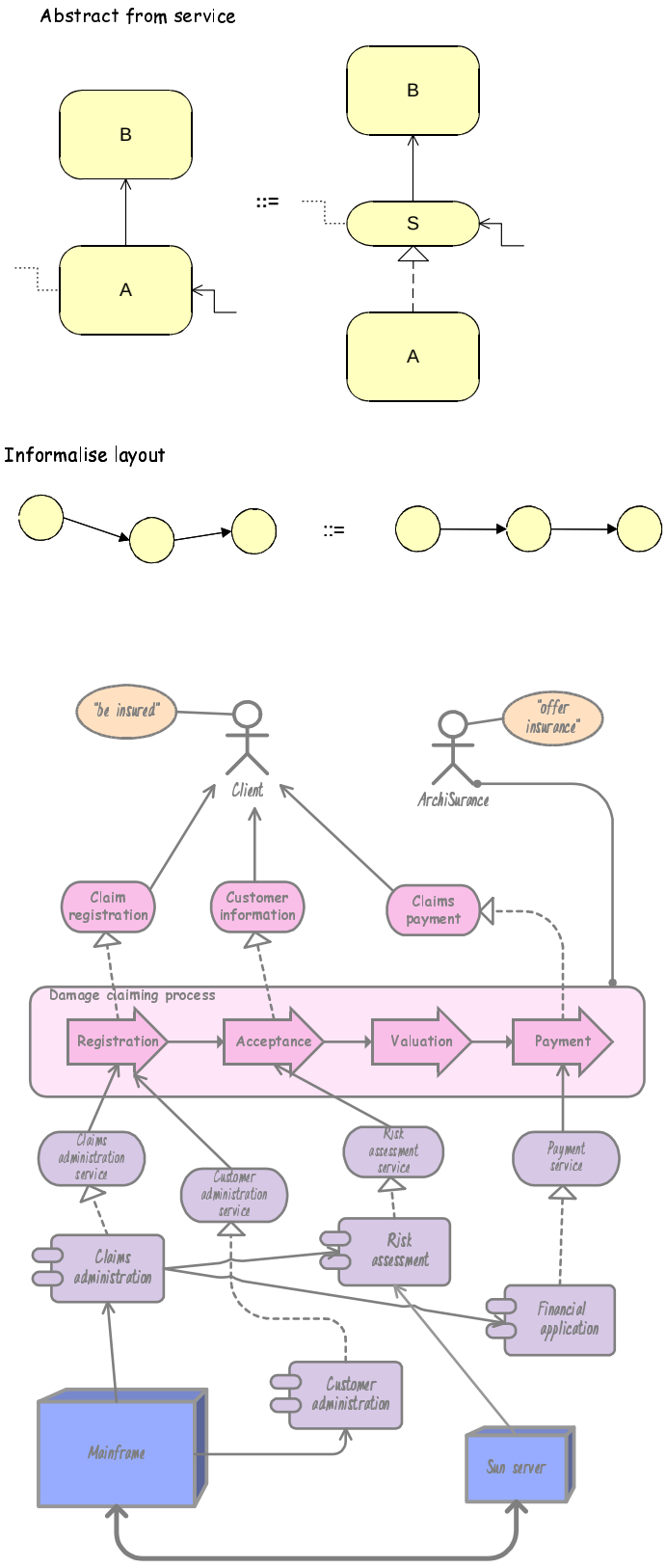


Figure 89. Step 4.

We can also abstract away entire layers of concepts. Figure 90 results from abstracting from all infrastructure concepts, from the container “damage claiming process”, from the application services, and from the assignment relation with the ArchiSurance actor, and applying “informalise shape” and “informalise layout” on the four subprocesses.

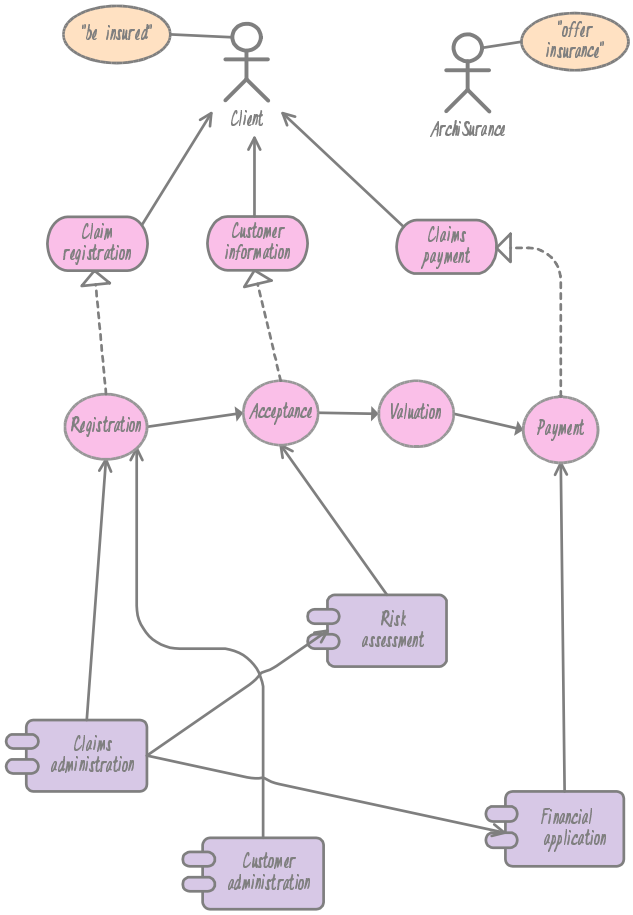


Figure 90. Step 5.

Abstracting from the application layer concepts and the processes realising the business services results in Figure 91.

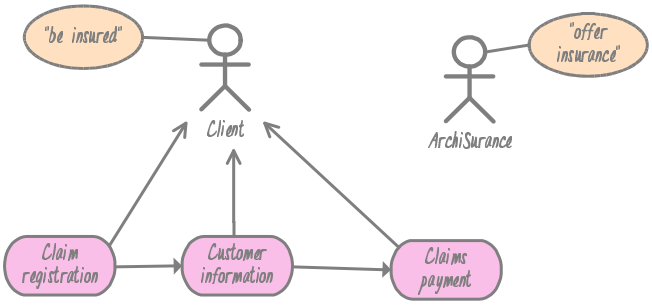
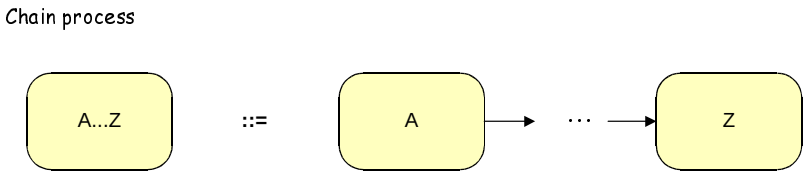


Figure 91. Step 6.

Finally, using “chain process” and “informalise colour” results in Figure 92.



The “chain process” rule is different from the rules that ‘abstract away’ certain objects. Here, a set of connected objects (processes) is replaced by a single, more abstract object representing the original set.

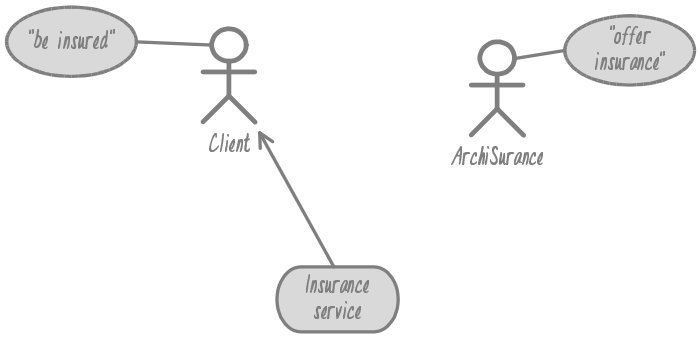


Figure 92. Step 12.

The previous examples show that these abstraction and presentation rules can be used to recreate the design process of a model “backwards”. Thus, they could be used to explain this design process to the stakeholders involved. Ideally, these steps would be linked to a record of this design process, described in the concepts for capturing design decisions developed in task T2.2.c. This is subject to further research.

Naturally, the “informalisation” rules can also be used in the design process itself. While parts of the design are not fixed yet, or have a low commitment in the organisation, their appearance can be changed accordingly. Conversely, fixed elements such as legacy systems may be visualised in a more formal way.

6 Decision Support Viewpoints

Decision support viewpoints help managers in the process of decision making by offering insight into cross-domain architecture relations, typically through projections and intersections of underlying models, but also by means of analytical techniques. Such projections and intersections are selections, transformations and mappings of ArchiMate models to lists, tables, matrices and reports. As such, decision support viewpoints create high-level, coherent overview of an enterprise architecture, providing the 'big picture' required by decision makers.

These views can take several forms, but in most cases they will not look like traditional models. Typical examples are cross-reference tables, lists, reports, and landscape maps (*landschapskaarten* in Dutch). In this chapter, we will expound on the latter. Landscape maps are a good example of a view that offers an overview of architectural information in a form that can be readily understood by users not schooled in reading complex models.

6.1 Landscape Map Viewpoint

Table 22. Landscape Map viewpoint.

VIEWPOINT NAME	Landscape Map viewpoint
STAKEHOLDERS	Enterprise architect Decision makers: managers, CEO, CIO
CONCERNS	Readability Reduction of complexity Comparison of alternatives
PURPOSE	Deciding
ABSTRACTION LEVEL	Overview
LAYERS	Business, application
ASPECTS	Active

We will introduce landscape maps by means of an example from our imaginary insurance company ArchiSurance. This will illustrate the need for and use of such an overview.

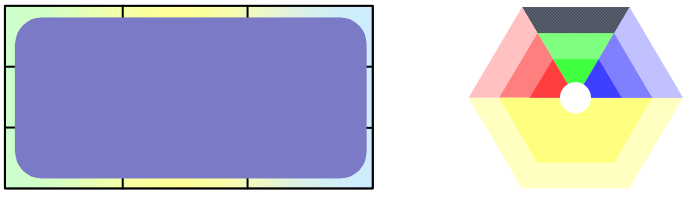


Figure 93. Position of the Landscape Map viewpoint in the conceptual and viewpoint frameworks.

6.1.1 Contents

A landscape map (*landschapskaart* in Dutch) as defined by Ordina (Van der Sanden and Sturm, 1997) is a matrix that represents a 3-dimensional coordinate system that represents architectural relations. The dimensions of the landscape maps can be freely chosen from the architecture that is being modelled. In practice, often dimensions are chosen from different architectural domains, for instance business functions, products and applications. In most cases, the vertical axis represents behaviour like business processes or functions; the horizontal axis represents "cases" for which those functions or processes must be executed. These "cases" can be different products, services market segments or scenario's. The third dimension represented by the cells of the matrix is used for assigning resources like information systems, infrastructure or human resources. The value of cells can be visualised by means of colored rectangles with text labels.

Figure 94 gives an example of a landscape map that shows which information systems support the human resources function. The vertical axis represents functions of human resource management; the horizontal axis gives different types of positions within the organisation. The meaning of an application rectangle covering one or more cells means that this particular function/position pair is supported by the application.

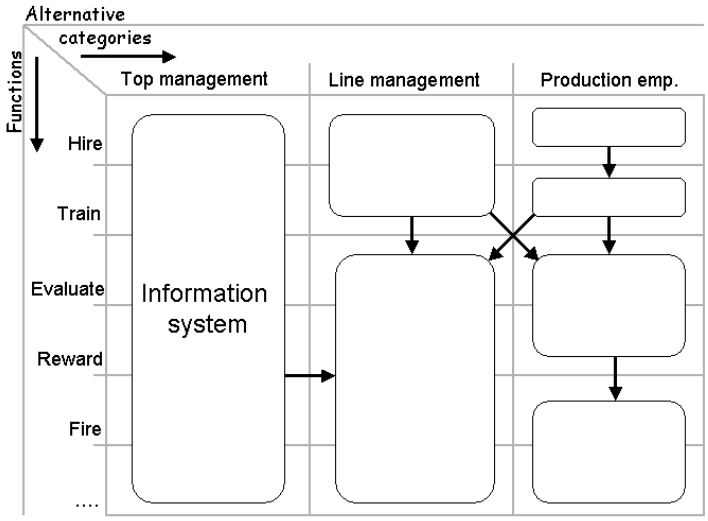


Figure 94. Example of a landscape map (adapted and translated from (Van der Sanden, 2000)).

Clearly, landscape maps are a richer representation than cross-reference tables, which cover only two dimensions. In order to obtain the same expressive power of a landscape map two cross-reference tables would be necessary; but even then, you would get a presentation that is not as insightful and informative as a landscape map.

Landscape maps can be used to publish an overview to managers and process owners or system owners. Architects may use it as a convenient tool for the analysis of changes or to find patterns in the allocation of resources.

6.1.2 Example

Many systems used by many processes realising various products and services comprise too much detail to display in a single figure. This is a typical example of where landscape maps can help. As shown in Figure 95, a landscape map of ArchiSurance's IT applications in relation to its business functions and products provides a high-level overview of the entire IT landscape of the company.

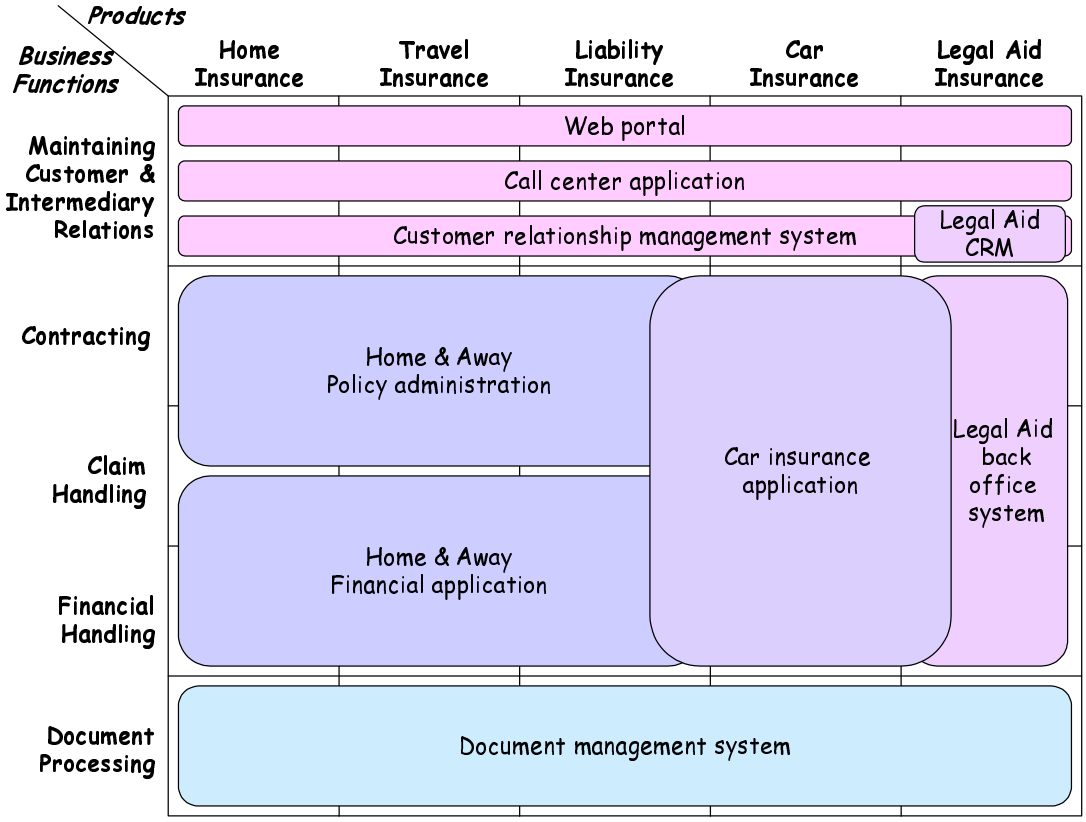


Figure 95. Landscape map of ArchiSurance.

6.1.3 Relation to Modelling Languages

So far landscape maps have been used as a notation without formal underpinnings. We propose to use landscape maps as a presentation format (modality) of enterprise architecture models expressed in the ArchiMate language. In this chapter we will show ArchiMate models can be mapped to landscape maps, and how landscape maps can be used as an interactive medium for architecture design.

The mapping of ArchiMate models on landscape maps is based on architecture relations. The dimensions that are used in the landscape maps determine which relations are used. For instance, the landscape map in Figure 94 relates business functions (hire, train, etc.) to roles (top management, line management, production employee) to systems (information system and applications). The relation between business functions and roles is directly supported by the assignment relation; the relation between roles and systems is indirectly supported: roles are assigned to processes (or functions) which in turn use systems.

6.1.4 Interaction with Landscape Maps

So far, landscape maps have been used as a static one-way presentation format. We want to use landscape maps as an interactive medium. Landscape maps can be used as a starting point for more detailed models and specifications and it can be used for entering relations between the dimensions chosen. Also changes in the landscape map can be analysed for impact on other elements of the map. We envision the following interaction primitives for landscape maps:

- Draw a rectangle (rubber band) comprising one or more cells of the map. The user may choose the color and assign an object (instance of a concept) to the rectangle.
- Extend an existing rectangle with another rectangle that overlaps with the original. Color and label are inherited.
- Modify a rectangle: coverage, color, value.
- Delete a rectangle.

Landscape maps can be used as a starting point for navigation as well; relevant interactions are:

- Open a rectangle: detailed specifications or detailed models are shown in a separate window.
- Close detailed specification or detailed models.
- Change granularity of an axis; for instance, business processes can be changed to business activities.
- Link two rectangles by a relation supported by the underlying concept. For instance, if rectangles represent systems, use or composition can be used.

We intend to develop a prototype based on these ideas.

7 Informing Viewpoints

7.1 Process Illustration Viewpoint

In this section we present, by means of an example, how views of the Process Illustration viewpoint can be derived from ArchiMate models using a set of translation and abstraction rules.

Table 23. Process Illustration viewpoint.

VIEWPOINT NAME	Process Illustration viewpoint
STAKEHOLDERS	(Enterprise) architects Managers
CONCERNS	Make design choices visible Convince stakeholders
PURPOSE	Communication
ABSTRACTION LEVEL	Coherence
LAYERS	Business, application, technology
ASPECTS	Active, behaviour, passive

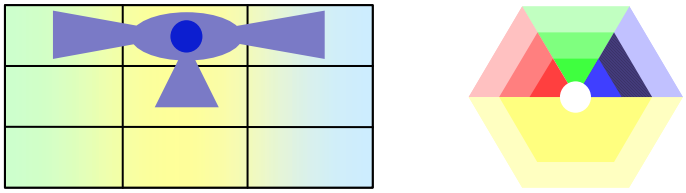


Figure 96. Position of the Process Illustration viewpoint in the conceptual and viewpoint frameworks.

7.1.1 Example

Our case is the Belastingdienst architecture for the collection of the BPM tax for imported cars. In what follows we give a textual description of this architecture and of the business processes it supports.

In The Netherlands any imported car is subjected to special kind of taxation called BPM. The business architecture supporting the whole collection process and the interaction of the Dutch Tax Department (Belastingdienst) with the importers and a number of other parties is described below.

Phase 1: “Customer Desk”

The importer (private person or car dealer/importer) must announce himself at the customer desk in any of the 30 Customs units in The Netherlands with the imported vehicle, its (provenance) documents, the approval proof of its technical inspection, and possibly with cash for the payment of the BPM tax.

The public servant will handle the tax declaration as follows: first he will check all the documents, then he will fill in all the data into a client BPM application (running on a local server) and will calculate the due BPM tax value. One copy of the BPM form (BPM17 ex 1) will be issued and sent to the administration. Another copy of this form is handed to the importer (BPM17 ex 3), together with either the evidence of a cash payment (if the importer is able to pay the BPM amount in cash), or with an "acceptgiro" bill issued for the due amount (in the case the importer is not able to pay in cash).

Phase 2: "Administration"

At each Customs unit there will be a public servant assigned to handle the additional operations regarding all the incoming BPM statements. Once a day, this person will collect all the incoming BPM17 forms. For the ones, which were paid in cash, he will issue and authorise another copy of the BPM form (BPM17 ex2). This copy will be sent to RDW ("Rijksdienst voor het Wegverkeer" - The Netherlands' Road Transport Department), which keeps the evidence of all registered vehicles in The Netherlands. The first copy of BPM 17 will be then sent to the archive.

The forms which are not yet paid, are temporarily archived and kept "on hold" until they are paid. The administration and notification of the payment for these BPM forms is done by a separate department of the Belastingdienst, namely the "Inning" is responsible for the collection of all payments via bank.

Once, such a notification is received (via the BPM server application) the administration will prepare and send the copy of BPM17 ex.2 to RDW.

Requirements

Below we give a number of business and technical requirements that must be fulfilled by this architecture:

- The client's (importer) application for a BPM application must be handled in one iteration ("one stop shopping").
- All the BPM forms are stored electronically in a central location (BCICT) in a central file, which is nationally accessible. The server BPM application (also located here) controls the access, updates and all the other operations on this file. It also provides support for the calculation of the BPM values, using data from another central/national file with the catalogue information/value of all existing models of vehicles. Finally, the server application will monitor the status of payments by interacting with the Inning Department and with the client BPM application from all Customs Units.
- Within each Customs unit, a client BPM application will run on a local server.
- The paper version of BPM17 ex 1 are archived at the issuing Customs Unit.

7.1.2 Contents

In Figure 97 we have depicted the ArchiMate model describing the above-defined architecture.

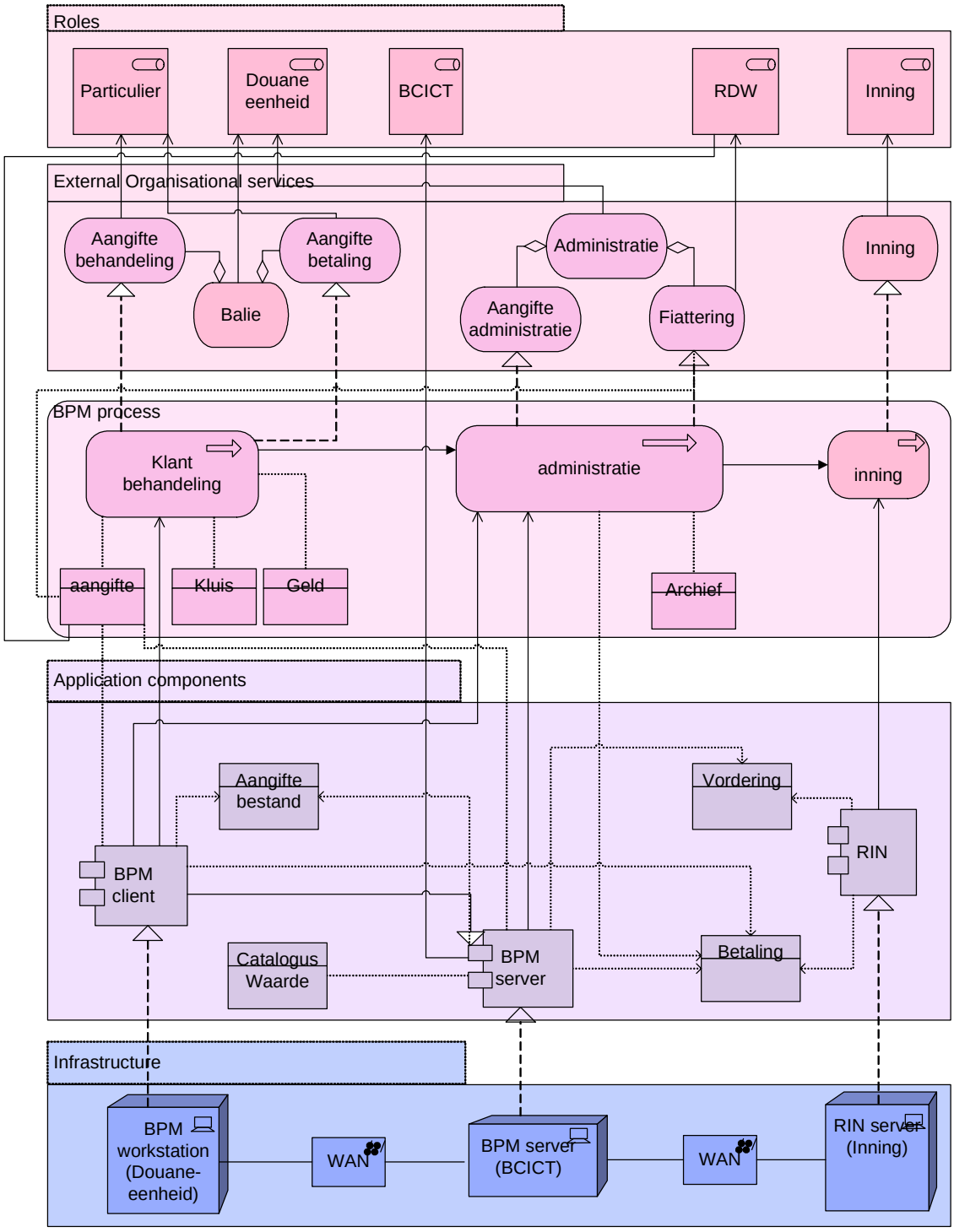


Figure 97. BPM architecture

Next we will show how a “process illustration” of this architecture can be derived from the ArchiMate model through the successive application of a set of translation, abstraction and presentation rules.

Translation rules

In Figure 98 one can see a number of translation rules that can be applied in a first step of the derivation “ArchiMate-to-Process Illustration” process. The basic idea behind these type of rules is to find suitable and intuitive graphic symbols that will replace ArchiMate shapes. These type of rules apply to ArchiMate concepts for which one can find an immediate correspondent in the Process illustration notation (i.e. actor, role, device, service, business object etc.).

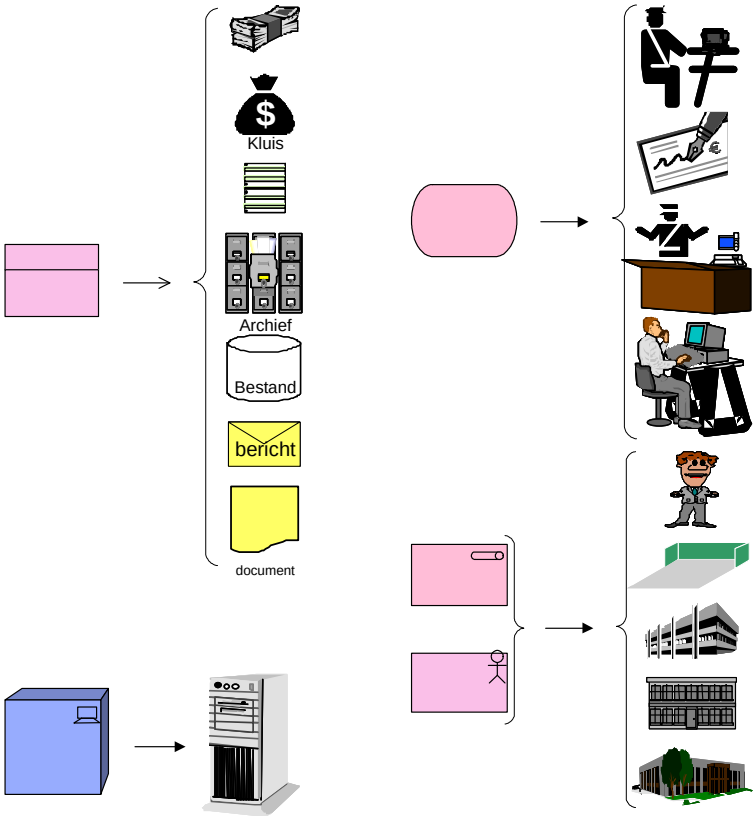


Figure 98. Translation rules.

A number of concrete translation examples are shown in Figure 99.

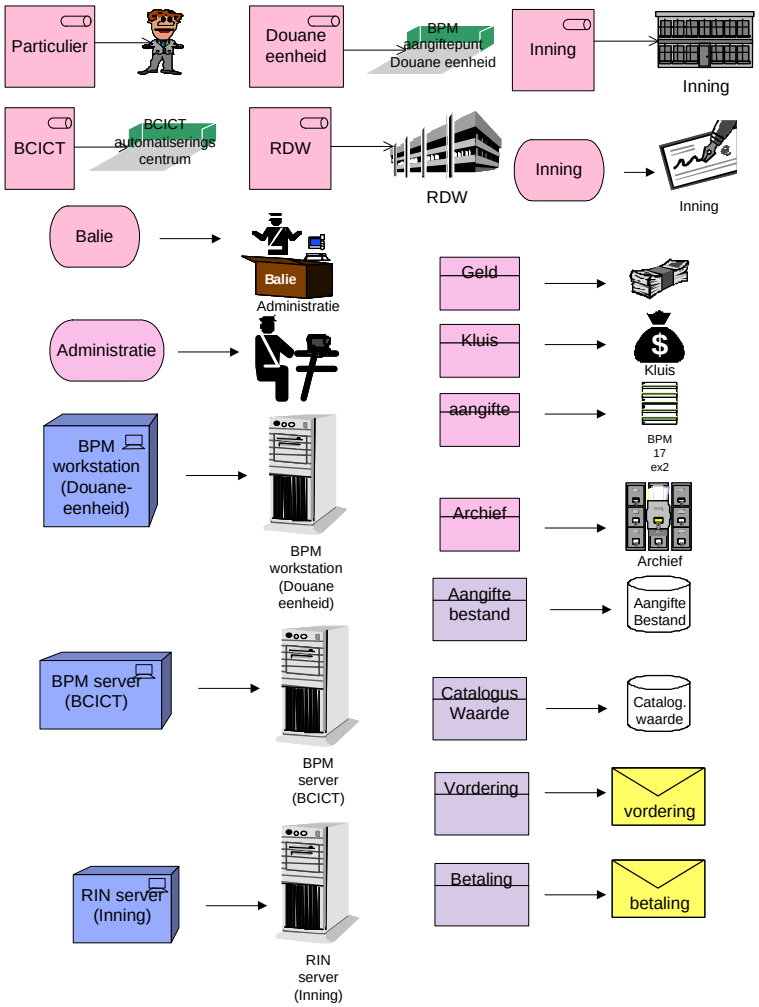


Figure 99. Application of translation rules.

The resulting BPM model after the application of the translation rules is depicted in Figure 100.

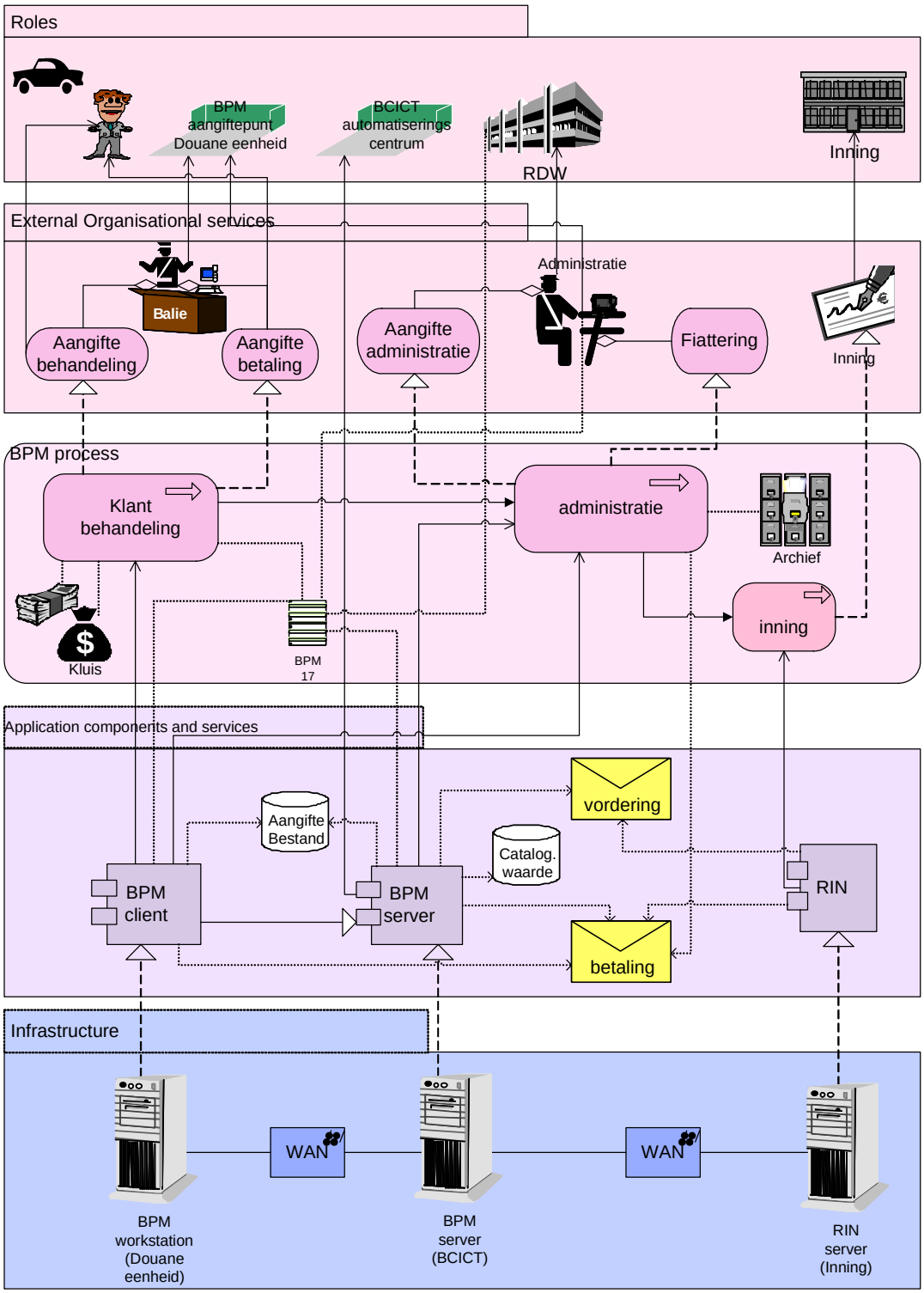


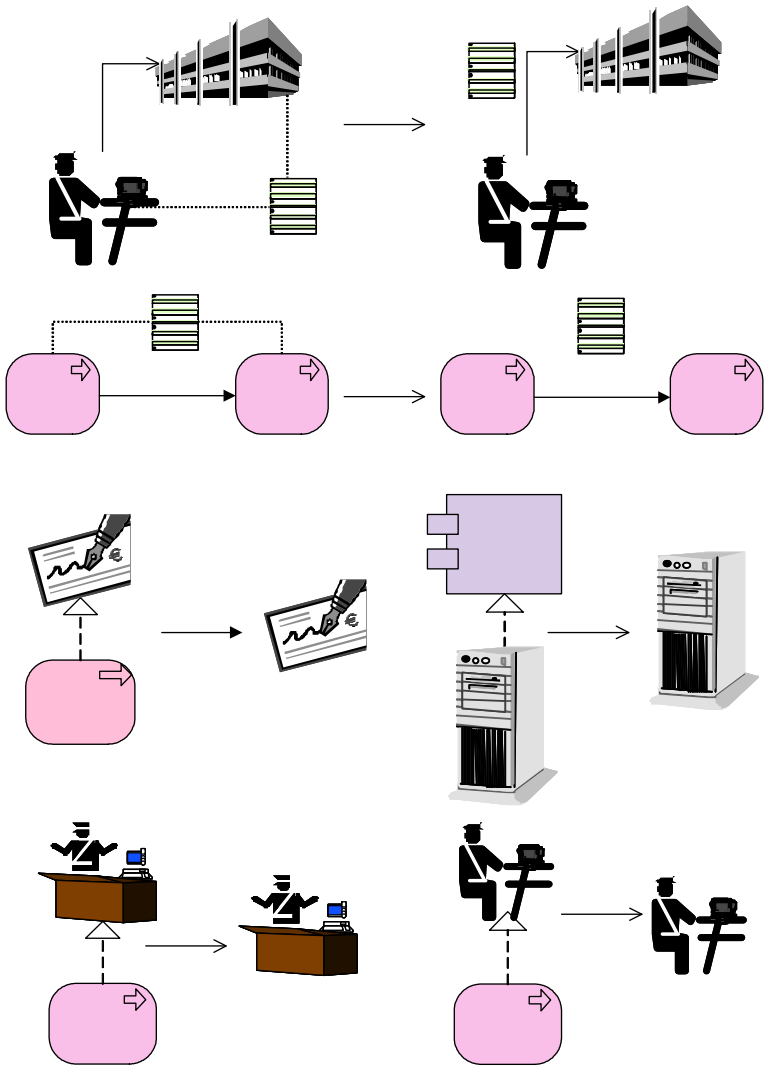
Figure 100. The BPM model after applying the translation rules.

Abstraction rules

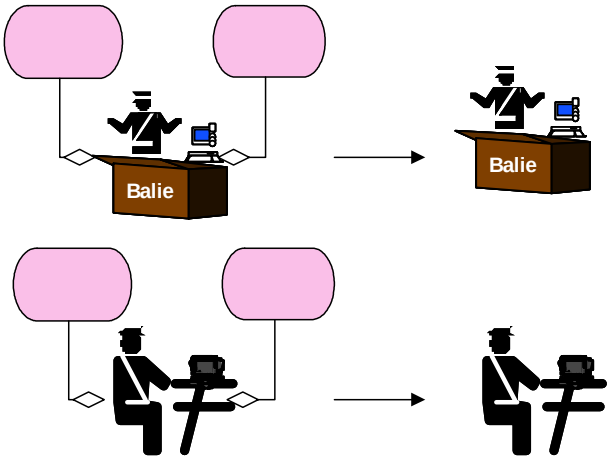
Most of the rules we apply for this particular derivation process, fall in one of the categories defined in Appendix A. We will classify them according to the same criteria.

- *Object type rules (see "Object type" in Appendix A)*

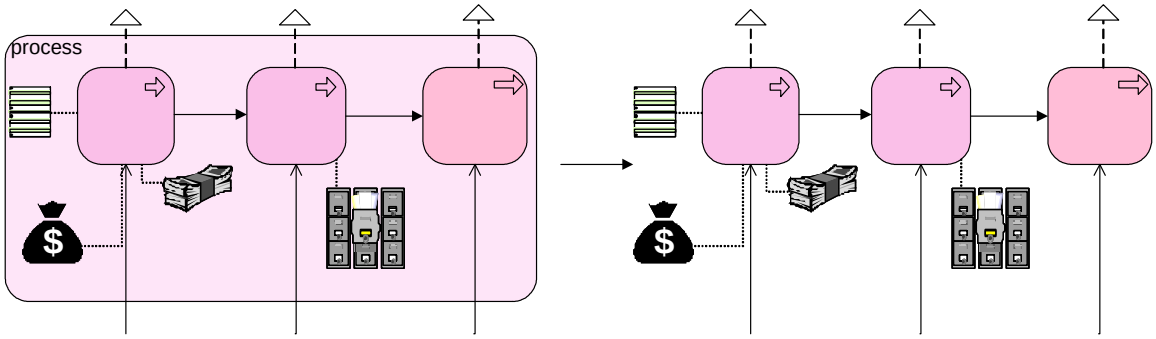
- *Relation type rules (see "Relation type" in Appendix A)*



- *Abstract from contents (see "Abstract from contents" in Appendix A)*

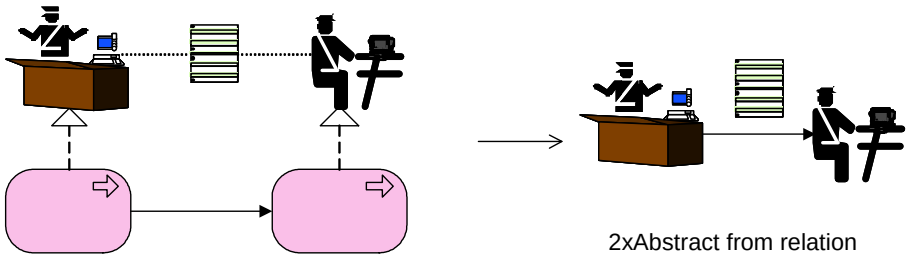


- *Abstract from container (see "Abstract from container" in Appendix A)*

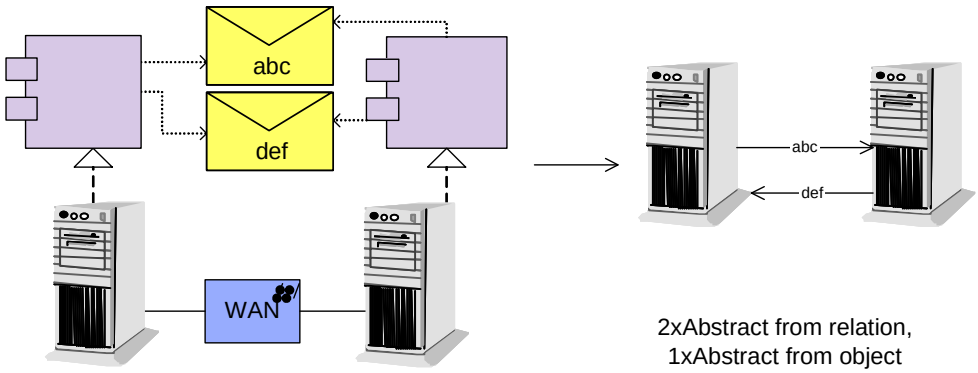


- *Composition of rules*

These rules are the result of successive application of two or more of the previously defined abstraction rules.



2xAbstract from relation



2xAbstract from relation,
1xAbstract from object

The resulting BPM model after the successive application in two steps of the translation rules is depicted in Figure 101 and Figure 102.

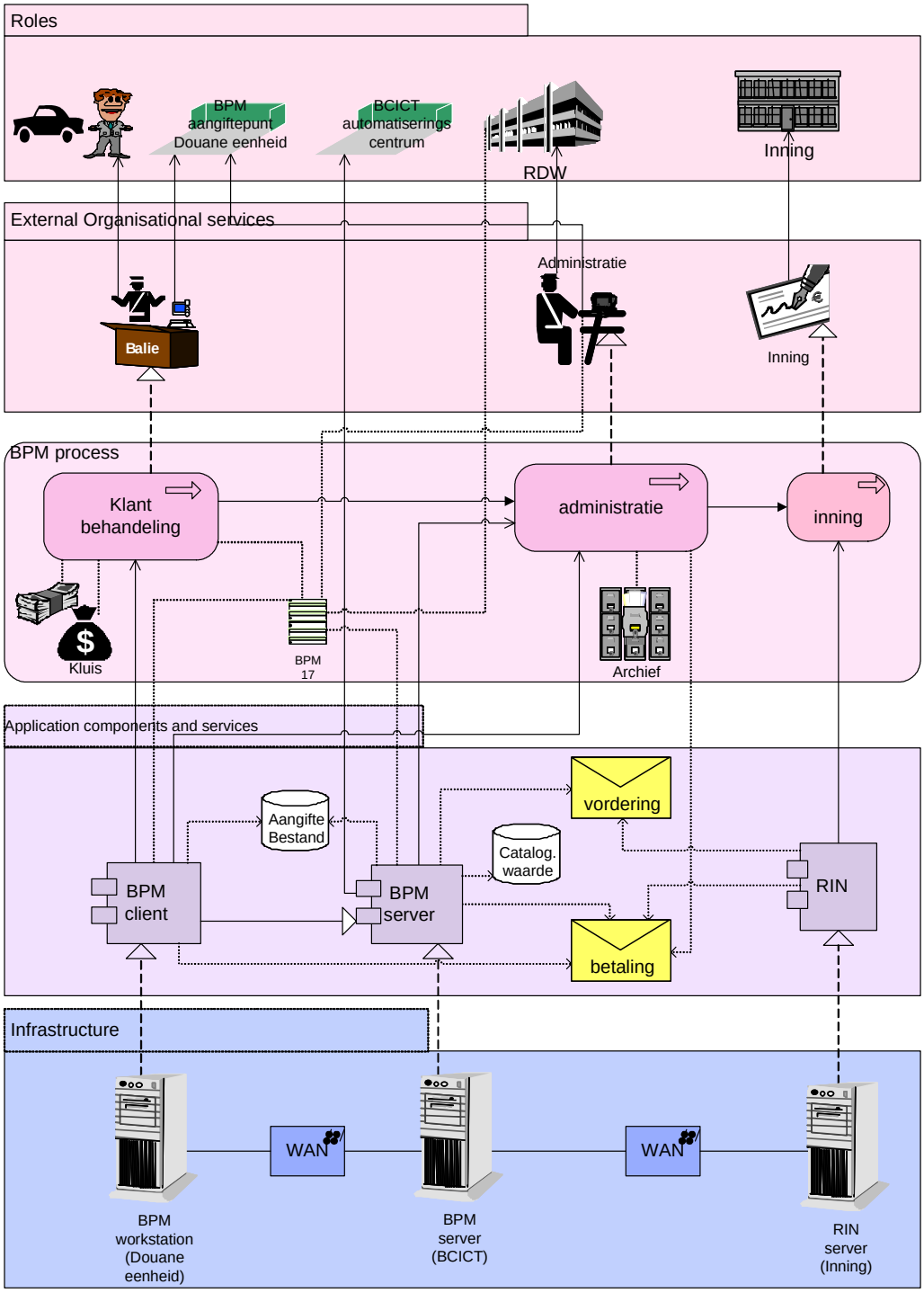


Figure 101. Application of abstraction rules: step 1.

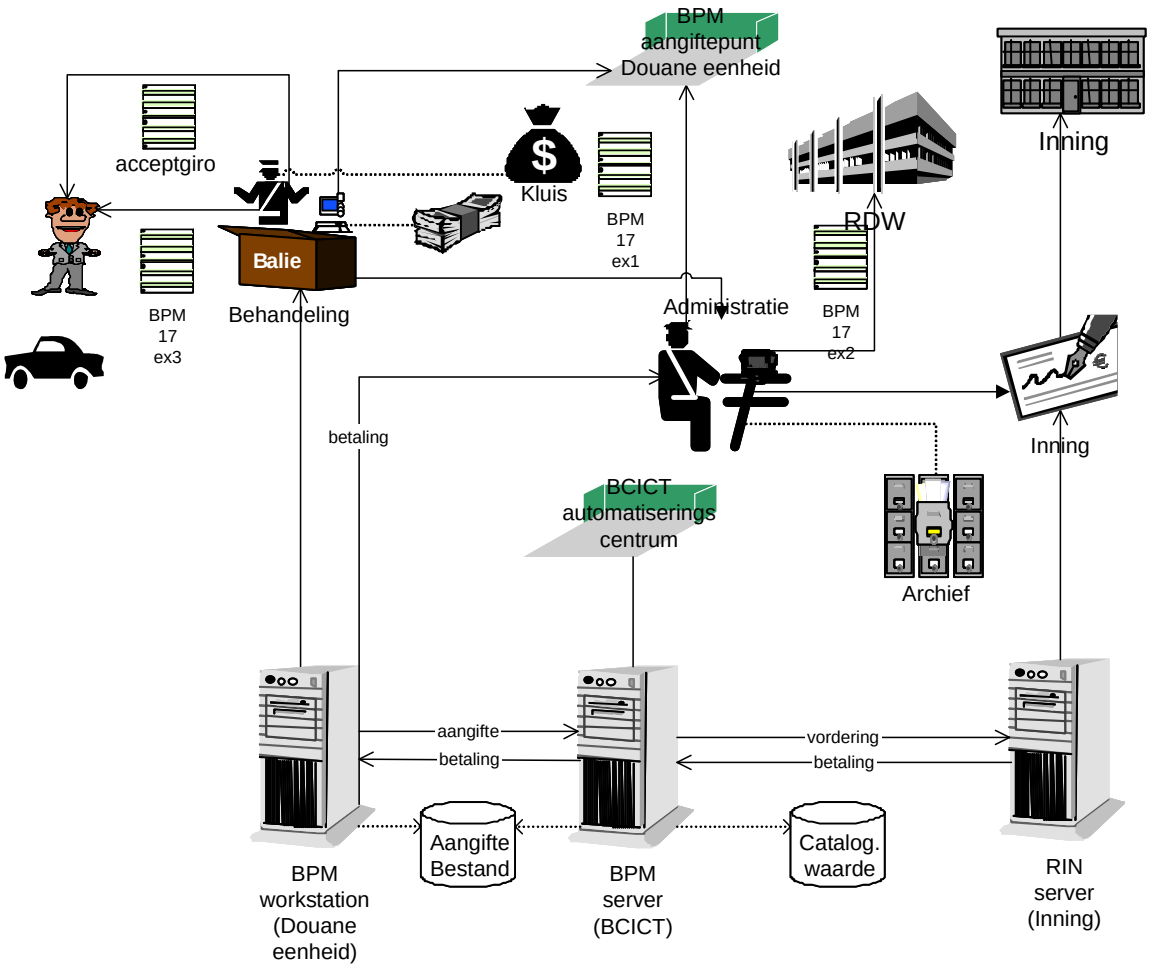


Figure 102. Application of abstraction rules: step 2.

Presentation rules

For this particular example we have identified visualisation rules that makes the whole design of the resulting diagram less formal and more intuitive. More precisely we refer to a “grouping” rule of all objects and relations that belong to or happen within a certain actor. In Figure 103 we give two examples of the application of such a rule.

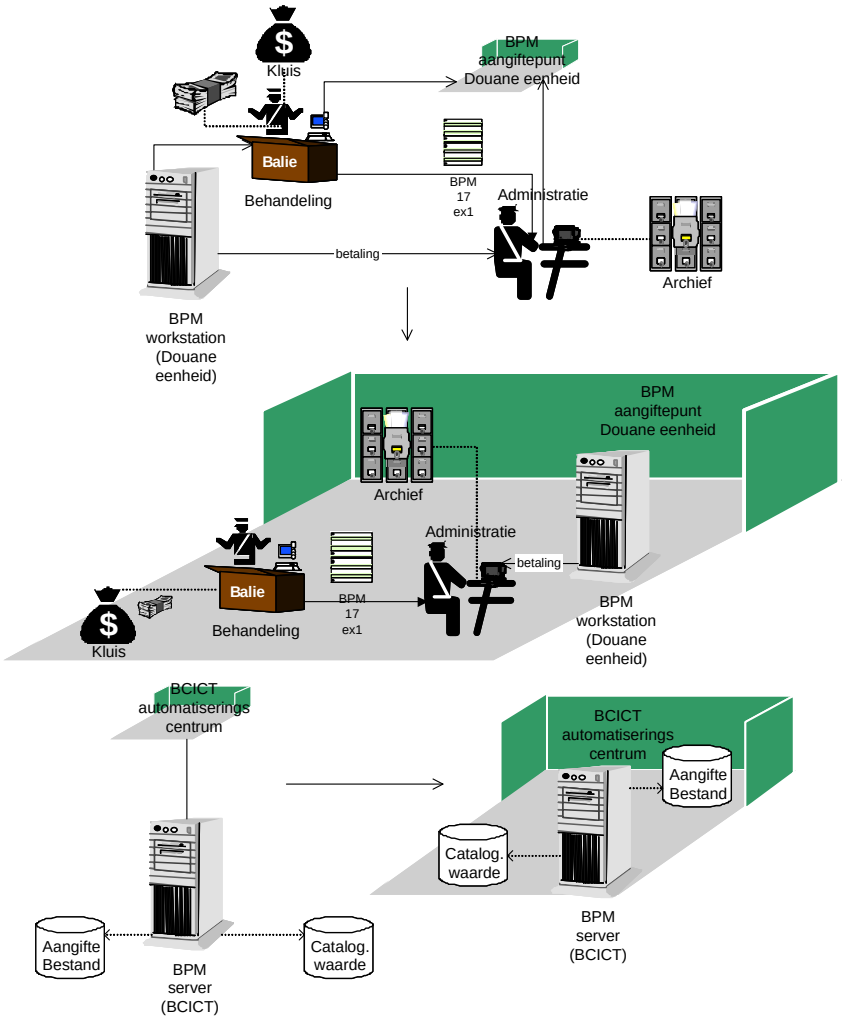


Figure 103. Visual grouping.

Of course, many other rules can be added here. For instance, rules referring to a specific layout of the final drawing or to the more extensive usage of 3D graphic symbols can increase the readability and usability of the final drawing (see Iacob, 2003). For the BPM example, the derivation process completes with the application of the above mentioned visualisation rule (see Figure 104).

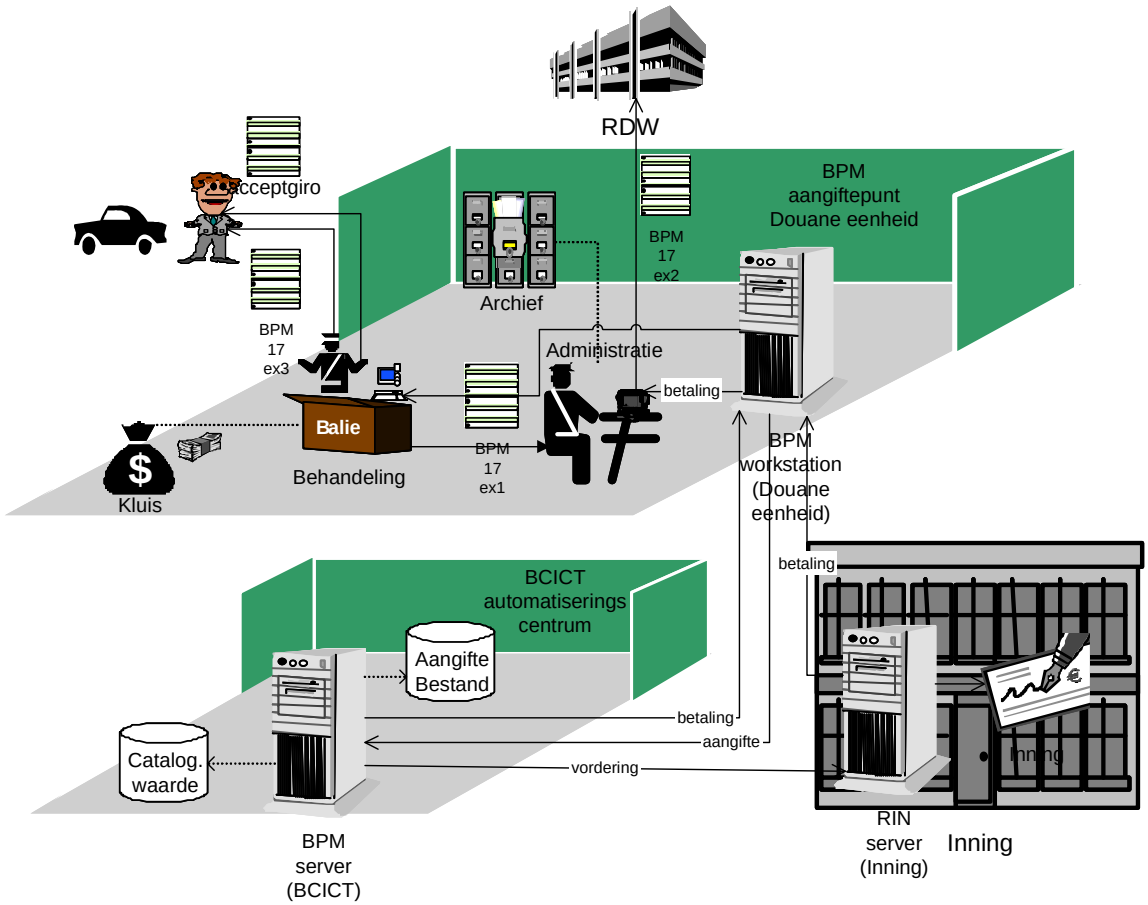


Figure 104. BPM process illustration diagram.

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Appendix A - Viewpoint Rules

Types of Abstraction Rules

Below, we list the types of abstraction rules to be supported by the ArchiMate viewpoint and visualisation engine. The examples show common instantiations of these rules; these must at least be supported.

- *Object type*

Objects of a given type are ‘abstracted away’. The relations that result (as defined by the rule) should be consistent with the RvB/HJ relation framework (Jonkers *et al.*, 2003). Common examples are abstraction from service, actor, role, interface, and behaviour.

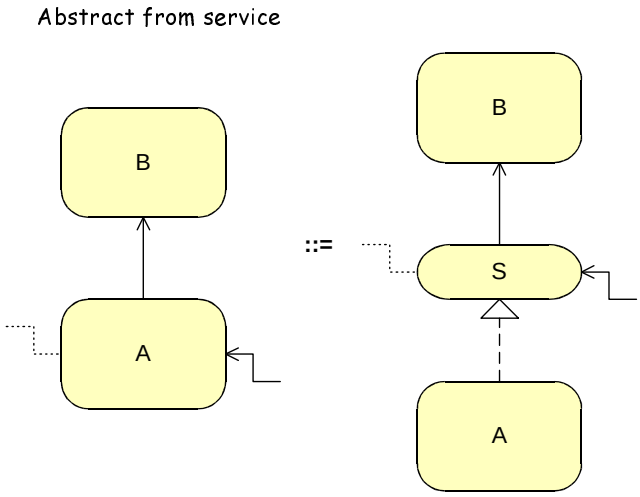


Figure 105. Abstracting from service S realised by A and used by B results in B directly using A.

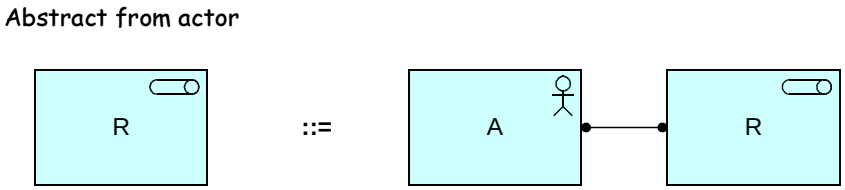


Figure 106. Abstracting from actor A fulfilling role R.

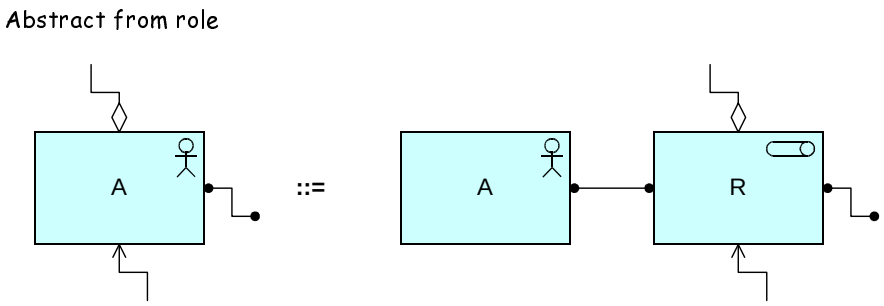


Figure 107. Abstracting from role R fulfilled by actor A.

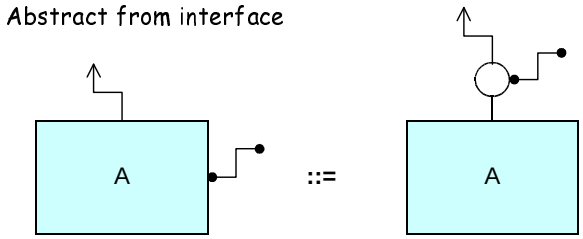


Figure 108. Abstracting from the interface of A.

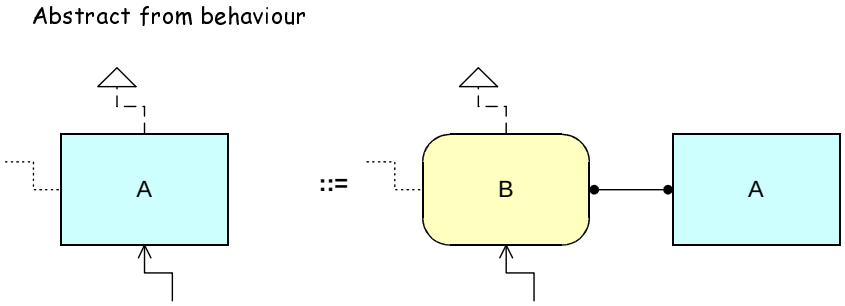


Figure 109. Abstracting from the behaviour B of A.

- *Relation type*

Starting from a set of objects, all objects connected through a specific relation type are abstracted away (unless they are also connected via other relations).

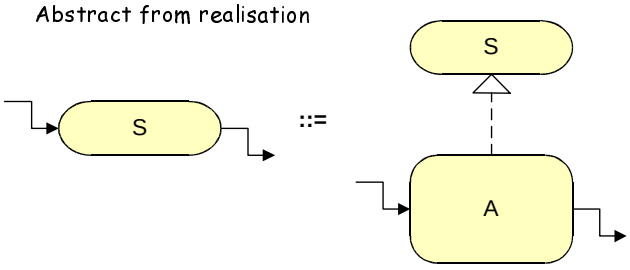


Figure 110. Abstracting from the realisation A of service S.

- *Abstract from contents*

Applying this rule to an object with contained objects will hide the contained objects. All relations to contained objects will be moved to the containing object. This is a special, but very common case of ‘abstract from relation type’, for the composition relation.

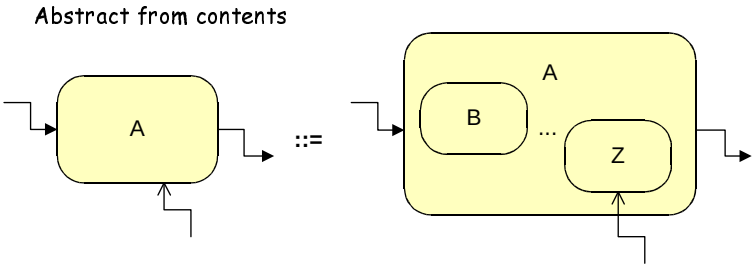


Figure 111. Abstracting from the contents B...Z of A.

- *Abstract from container*

Applying this rule to an object with contained objects will hide the containing object. All relations to the container will be duplicated to every contained object.

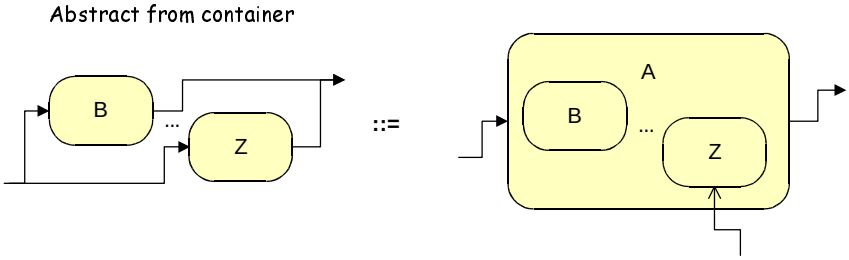


Figure 112. Abstracting from container A of B...Z.

- *Neighbourhood*

Starting from a set of objects, abstract from objects that are *n* or more hops away.

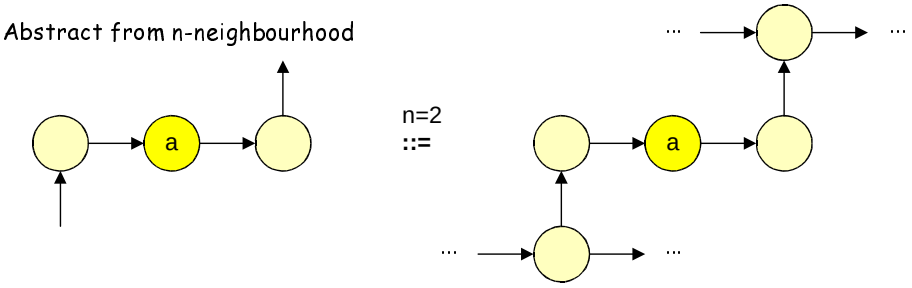


Figure 113. Abstracting from objects *n* or more hops away from object *a*.

Abstraction from objects outside the neighbourhood of a given set of objects is especially useful in navigation across a large architecture, where you may selectively zoom in on part that are of interest.

- *Binding strength*

Objects with a high internal cohesion and low external coupling can be abstracted into a single object. The binding strength between objects is determined by:

- The number of relations between these objects;
- The type of relations involved. The binding strength of a relation is related to its 'priority' (in the RvB/HJ framework);

- The type of the objects. E.g. objects in the same layer of the conceptual framework have a higher binding strength.

An example of this type of abstraction is combining a chain of process steps into a single process object.

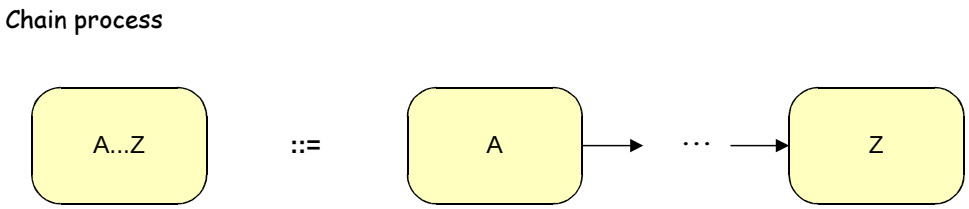


Figure 114. Abstracting process chain A...Z into a single process.

- *Attributes*

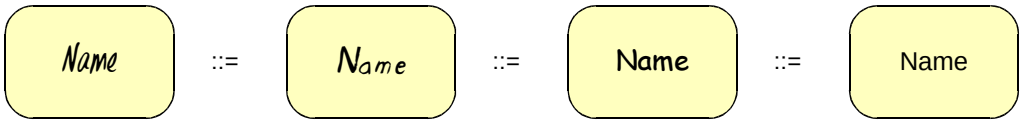
Objects with (or without) certain attribute values are abstracted away.

As can be seen from the above, we use two types of abstraction in the different abstraction rules. First, we can 'abstract away' certain objects, as for example in the "abstract from service", "abstract from container", or "abstract from role" rules. Second, we can replace a set of objects by a single, more abstract object. This is done in the "chain process" rule.

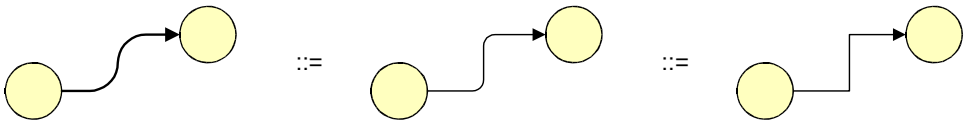
Presentation Rules

Below, we list a number of presentation rules that can be used to represent the uncertainty in a model. Typically, it is advisable to represent those parts of a model that are in an early stage in a less formal way to avoid the reader having the impression that the design is fixed. Conversely, parts of the model with a fixed status (e.g., legacy systems or other elements with a high commitment from the organisation) should be represented in a more formal fashion.

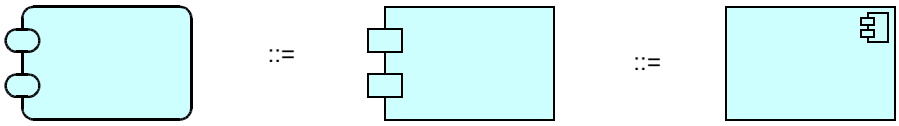
Informalise font



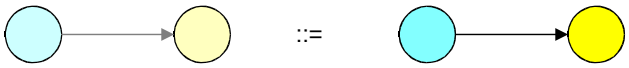
Informalise line



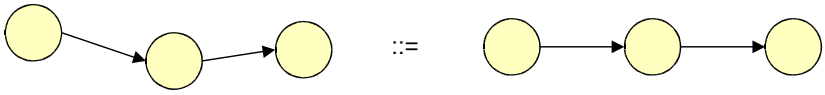
Informalise shape



Informalise colour



Informalise layout



Appendix B - Graphical Notation

In the picture below we summarise the graphical notation for the ArchiMate concepts and relations as proposed in (Jonkers *et al.*, 2003). In most cases the graphical notation has been taken over from standards such as UML or other architecture tools. For the behaviour and structure concepts we propose a choice between two notations. Take for instance the behaviour concepts, which are represented by a rectangle with rounded angles or oval shape. In order to distinguish the different concepts an icon is placed within these graphical representations. We propose to use these icons as a possible notation as well.

Note that in ArchiMate we separate the concepts from the presentation. This means that in principle another notation can be used, without losing the meaning of the ArchiMate metamodel.