A Sustainable Architecture for Durable Modeling of Laws and Regulations and Main Concepts of the Durable Model

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Abstract. The authors have been involved in durable modeling of laws and regulations to be used as the formal, testable and in a multi-disciplinary group understandable requirements for law and regulation based services. At least one co-creation initiative in the Netherlands has decided to develop an extended protocol for durable modeling of laws and regulations. The vast majority of these services and actions are information-intensive and require a substantial IT effort. The main ideas underlying the protocol developed in the last three years in the Blue Chamber are described. Durable modeling of laws and regulations can only be practically applied, whenever the result is recognizable by stakeholders and can be used for the modelling of services based on these laws and regulations. To test this assumption, we illustrate the protocol using the new Dutch environment planning act.

Keywords: Durable modeling for regulation based services · Legal services · Environment law · Case histories · Fact Based Modeling (FBM) · Legal domain specific protocol

1 Introduction

Legislation is the basis for all public services. Legislation is the union of laws, government decrees, ministerial decrees and several other regulations, including court decisions. The legislation describes very roughly speaking which rights and duties are applicable for a specific citizen or enterprise and under which circumstances. To deliver the intended services, governmental organizations face the challenge of understanding the intended semantics of the legislation and of transforming these intentions to durable and tested specifications.

The development of durable and tested specifications is considered the major obstacle for delivering the actual services within time and budget [8]. The intent of the legislation needs to be faithfully applied in all practical cases [14]. There is a need for a protocol such that a durable model can be used as solid basis for all the stakeholders involved as the formal, tested and accepted model of the associated services and

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enforcement actions [5]. In this paper we propose an architecture that uses fact based modeling as the main part of this protocol and the durable model.

In section 2 we describe the key characteristics of the desired situation. In section 3 we propose a sustainable architecture for the desired situation. The architecture relates the three major actor groups and the facts and rules they use or produce. The architecture provides a solution for the fundamental problem: a fact based durable model between legislation and the actual services. In section 4 we describe the requirements for such a durable model. In section 5 we discuss what we can learn from biology when we apply the durable model. In section 6 we present the key characteristics of the elements of the durable model, using the legality principle that requires a faithful representation of the intended semantics in practical cases. We present the clear connection between the facts at the scenario level and the fact patterns at the regulation level, an essential part of fact based modeling with CogNIAM [17]. In section 7 we discuss the advantages of this strong connection and the fact that in the legal services world, testing at the scenario level has been used since a very long time, long before IT arrived. It is called in that community *case histories* as part of a regulation impact analysis. In section 8 we present two cases associated with the new environment act. We use these cases to exemplify how our sustainable architecture can be the bases for a durable model of law and regulations. In section 9 we present a summary and suggestions for the road ahead.

2 The Key Characteristics for the Desired Situation

To achieve the desired situation for the durable modeling of laws and regulations, a co-creation initiative "Blue Chamber" was started in The Netherlands in 2012, consisting of government institutions, universities and innovative companies. In the spring of 2013 the Blue Chamber published its first report regarding regulation based services in The Netherlands. [8]. It concluded that the current situation is far from ideal. The key characteristics for the desired situation have been described in this report as follows: "In legislation rights and obligations are defined: among citizens, citizens towards the government and vice versa. Legislation contains concepts, rules and conditions that directly affect the actions of citizens, businesses and government organizations. These concepts, rules and conditions form the basis for the services and processes of public implementing bodies. For the following reasons, it is important to be able to distill concepts, rules and conditions from the legislation in an unambiguous and repeatable manner:

A. It promotes legal certainty for citizens and prevents unnecessary disputes and proceedings in court.
B. It enhances the transparency of government. The government can show that what they are doing is in accordance with the democratically established legislation. This includes providing insight into the rules that give the authorities a margin of discretion to do justice in special cases.
C. It simplifies implementation of legislation in services and processes. Thus, orders from politics and public demands can be accommodated more rapidly.

D. It improves an implementing body's capacity to, as part of ex ante feasibility tests, to provide feedback on proposed changes in legislation. This contributes positively to the effectiveness and efficiency of the implementation.
E. It provides insight into the coherence of the complex of legislation. Consequently, generic and specific elements in processes and services can more easily be distinguished. This offers possibilities for reuse, not only within an organization, but also between organizations.

In short, the added value of a repeatable approach to the organization of the implementation of legislation comes from the ability to transform legislation into legitimate and services for citizens and businesses that they experience as meaningful and to perform this in a truthful, efficient, multidisciplinary and timely fashion." [8]

3 A Sustainable Architecture for the Desired Situation

In this section we present the major actor groups in the entire process from initial wish for a law or regulation or modification of a law or regulation up till and including the running service. In the diagram below the three main actor groups are presented as well as which information or rules they read and/or which information or rules they write. [1, 7, 8, 10]

The first actor group consists of law makers, government and ministers. When they observe desired or presumed or identified needs, they start a new law and which are followed by associated decrees, or start to modify an existing law and associated decrees. The government service organizations can also modify or introduce a new operational policy. Judges are an important subset of actors in this group. Their decisions can have an effect on the service execution with regard to similar cases (jurisprudence). It is the combination of the work of these actors that determines the effective regulation.

To give all stakeholders due credit: although actor group 1 executes a process for the creation and modification of the regulations, this actor group doesn't undertake this process alone. Stakeholders like citizens, business and governmental organizations take part in the process, and in the end it is the corresponding legal authority that formally takes the decision (for example: cabinet and parliament for laws, town counsel for municipally rules).

Regulations are produced to provide services for the citizens and enterprises, or have them perform certain duties. These services are information-intensive and often heavily supported by IT. The traditional textual representation of law performs a more than excellent job in creating legal security, along with all the legal authorities. However, a textual representation lacks the necessary "hooks" and explicitly depicted relations between these "hooks" to be used as support for the specification of services.

What is needed is a complete specification that takes the (new) laws, decrees and policies as input and produces a well-tested and by the various stakeholders agreed and therefore accepted specification of the interaction between the government service providers and the citizens or enterprises. This is a multidisciplinary effort [9, 14] and in principle independent of IT or in case of human processes, the specific implementation

of these human processes such that new IT technologies and other organizational structures can be based on the durable specifications or model.

Actor group 2 also provides the two-way references between the durable model or specifications and the regulations. The group consists of legal experts, service experts and architects. A two-way reference is needed for impact analysis [19]. Often this is also referred to as annotation services. As can be seen, the specifications of the durable model can be represented with traditional Word, PDF or Excel documents, or by the so-called juridical DNA, a representation that can be consulted with a logical language. An organization has a choice. No matter what the choice is, there is a need to know which requirement is based on which pieces of texts in the regulations. This is represented by the arrows with the A and B in a circle.

Actor group 3 consists of the service builders. Such services can be processes performed by humans or by machines. At the current state of affairs, the majority of services are heavily based on IT services. The builders can use the specifications depicted in the durable model in the same way as a builder of a large office block uses the blue prints of the architect. We have already seen cases in which this building process has been automated, creating IT services directly from specifications.

Actor group 4 consists of the citizens or enterprises that receive the services of the government service provider or the duty dispatching service. Actor group 5 consists of civil servants offering human services.

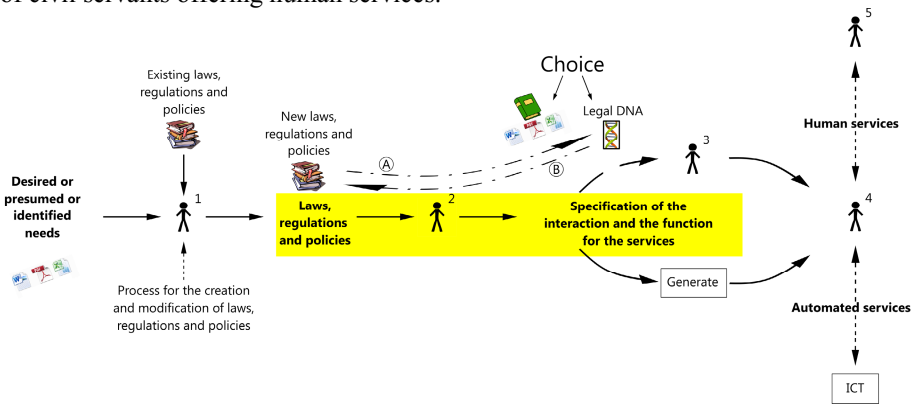

Fig. 1. A sustainable architecture

The validity of the sustainable architecture is supported by the fact that a number of Dutch governmental organizations have already implemented parts:

- The Dutch Taxation Office has issued a European tender in late 2013 under the name Annotation Services, to provide the starting point of two-way links between the durable model and the original laws, decrees and regulations [19].
- The Dutch Land Registry has published the two-way links between registration facts and the corresponding legislation at http://tax.kadaster.nl.

- The Ministry of Infrastructure and Environment has stated[1] that the success of the new environment planning act depends upon the availability of a durable model as a link between legislation and public services.

4 The Requirements for a Durable Model

One of the requirements for which the law makers are not willing to compromise, is that the services provided should be fully based on the regulation and faithfully represents the intended semantics in cases. This is referred to as the legality principle. Only services that are described in the laws, regulations and policies are legally permitted. Commercial organizations can do anything but what is not prohibited, governmental organizations services are rooted in laws and regulations. [8, 14]

Hence that means that the durable model must include a two-way link between the services and the (textual) representation of the legislation, and represent the full semantics as intended in the legislation (regulation level) to apply to all the foreseen cases (scenario level).

5 What can Modelers Learn from Biology?

Mankind has learned a lot about biology by applying a microscope. Look for instance at the development of modern medicine. To produce a durable model for laws, regulations and policies we try this same idea on our main object of study. One of the unique principles of the Blue Chamber is indeed based on a well-accepted principle in some natural sciences: "Use a microscope, describe what you see and generalize towards a consistent theory".

We can learn from biology that the study of laws is an empirical study. It is a study that gives you a model that explains to a practical point the way a law works. The quality of a model is its explaining power (is it useful?), and its truthfulness (is it an acceptable representation?). In the same way, our study of the legislation is an empirical study. It is a study that gives us a model that explains to a practical point the way the legislation works.

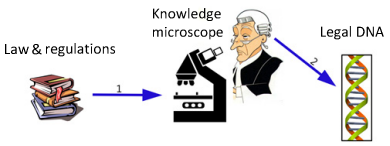

Fig. 2. The knowledge microscope

[1] This statement can be found in the administrative covenant regarding the implementation of the environment planning act: bijlage bij kamerstukken II 2014/2015 33118, nr. 19, https://zoek.officielebekendmakingen.nl/blg-546306.

The Blue Chamber has accepted this principle and makes use of a so called knowledge microscope. Hence put a sufficient set of regulation text under the knowledge microscope and conclude which knowledge elements are needed to fully describe the semantics for all relevant practical cases. We use the knowledge microscope as a way to have a truthful model (step 1). But we won't present our microscopic observations as-is: an abstraction is necessary to give an acceptable an understandable explanation of the observations (step 2). In the analogy of biology: after the discovery over a certain type of bacteria under the microscope, the doctor announces that the patient has the common flu. The observation is "bacteria type". The acceptable explanation is the abstraction to a human level of a particular decease.

The knowledge microscope is operated by a durable knowledge modeler who submits questions on concrete cases to a legal expert or an experienced service provider or architect. It is used by actor group (2) as depicted in the architecture: a multidisciplinary group that works together in co-creation to specify the durable model or as we call it: intelligent specifications.

6 Key Characteristics of the Durable Model

The language to describe the durable model (regulation level) must be capable of describing **explicitly** what the intended semantics of the regulations are in the associated practical cases (scenario level). Here we see a strong link between the scenario level (the level of the facts) and the domain specific regulation level [16, 17].

How do we find out which constructs are needed in durable specification language? By applying the knowledge microscope to a representative set of regulations, se have applied the microscope to a number of regulations and this has resulted in the following list of constructs:

1. Fact patterns, to precisely define the scope;
2. The associated integrity rules that define the quality of the facts of the cases;
3. The associated concept definitions and the references to the legal sources, that provide a description of each term for which there is any doubt that the members of the community have no clear definition;
4. The associated derivation rules, specifying which facts can be derived from other facts (including the derivation of institutional facts from brute facts);
5. The associated behavioral rules, specifying which actor can assert which facts according to which guidelines, following an extended Hohfeld typology (see end of this section);
6. The associated fact communication patterns, providing a tool to communicate the deep structure of a fact in any surface structure selected by a community;
7. The associated rule communication patterns, providing a tool to communicate the deep structure of any rule in any surface structure selected by a community;
8. The associated events, specifying the conditions that start the execution of a derivation rule or behavioral rule;

9. The concept of context, specifying one or more pieces of text within one or more different regulations together forming a context, within which a concept definition is valid for a specific term and
10. The concept of relevant regulations (relreg) introduced by Robert van Doesburg under the term "script" [9], specifying all the pieces of regulations from one or more different regulations that are involved in the often many cases that follow a certain legal act until all the specific cases come to an end.
11. The domain of regulations specific concepts of legal relations and legal actions (extensions to Hohfeld) which can be expressed with the previous 10 constructs.

Please note the concept of context is used to define the boundaries within which a certain term has a certain definition, while the concept of relevant regulations contains a set of pieces of (often) various regulations that define the rules applicable to a prototypical legal act.

The Hohfeld [2, 3, 12] typology is basically a typology of the right-duty pair. He called such a pair in which one party has the kind of right and another party the associated kind of duty a legal relation. Hohfeld had studied before 1913 a number of decisions by various courts, or cases. We could see he used the knowledge microscope principle already over 100 years ago. He came to the conclusion that four different pairs were needed, the claim-duty, the liberty(=privilege)-noright, the power-liability and the immunity-disability. His two publications are landmarks and recommended reading for every one that is concerned with modeling of laws [11, 18, 19].

Hohfeld used his typology of legal relations in the context of court decisions. His model didn't include the creation of new legal relations. In the Blue Chamber we have accepted Hohfeld as a solid basis, to be extended with requirements to include the creation of new legal relations and to use the Hohfeld typology in the context of Dutch legislation.

Creation of legal relations is possible by a solid distinction between a legal relation and a legal act [5]. A legal relation is a state between two parties, having a start time and possibly an end time. A legal act is an act by one party related to a legal relation the party is part of. A legal act can take place at one moment in time or a period in time.

In the Blue Chamber we have come to the conclusion that applying the knowledge microscope principle to Dutch laws and regulation we need to extend Hohfeld with at least one new pair to properly represent the pair DutchClaim-DutchDuty. This will be described in a forthcoming paper.

7 Strong Connection between the Scenario Level and the Regulation Level

In the Blue Chamber we have come to the conclusion that cases are first class citizens. Without expected cases there is no need for a law or regulation. Hence we have come to the conclusion that there is a strong bond between the domain specific level of the rights and duties extended with concepts described above. A case consists of a

set of facts. A fact is an event or circumstance which is considered real. In the brute reality brute facts occur. All actions of people, business and governmental organizations are facts that take place in brute reality. But some of these facts are considered "special": those facts result in corresponding institutional facts: facts that correspond to institutional regulations. These regulations (regulation level) dictate which institutional facts can occur.

Legal relations and legal acts are institutional rules. How do rules at the regulation level relate to facts at the scenario level? A fact shares a part of a fact pattern at the regulation level, namely the part that is constant for all fact instances belonging to a fact pattern. And every rule refers to one or more variables in a fact pattern. Voila, the connection between the facts at the case or scenario level and the rules at the domain specific durable model level have the common link of the constant part of a fact and the corresponding part of the fact pattern, sometimes referred to as fact type [17].

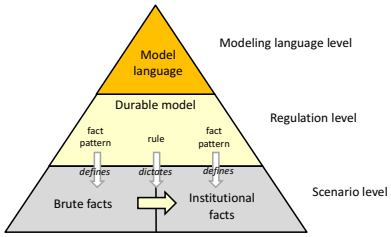

Fig. 3. The knowledge triangle

One of the interesting experiences of working with the principles listed above is that the strong connection between the scenario level and the regulation level makes many things much clearer. The scenario level is well known in the legal world, although underrepresented in the text books.

Before a regulation is put into practice so-called *case histories* are tested as part of an *ex-ante* (Latin for "beforehand") regulation impact analysis. That means that before the actual implementation of the regulation, a number of relevant cases are investigated. We can imagine that the durable model can actually be used during this phase. Although we are very careful not to impose a (different) formal model on the process of lawmaking, we have found that the feedback that such a model gives can be useful in playing with the different scenarios at the scenario level. We have played such roles in collaboration with a number of law experts and this has resulted in substantial insight into the deep structure of elements in regulations and the understanding of legislation by non-legal professionals.

8 Two Related Cases for the New Environment Planning Act

We will now describe two related cases. The physical environment includes constructions, infra-structure, water, soil, air, landscapes, nature and cultural heritage. Citizens, businesses and governments conduct activities that affect change in the physical environment or habitat. Such activities change the usability, health or safety of the

physical environment for others. Conflicts of interests can easily occur, due to the fact that parties have different stakes with regard to the same (piece of) environment. These conflicts were prompted to propose rules on activities in the physical environment.

The current environmental law is fragmented and spread across dozens of laws. There are separate laws for land, building, noise, infrastructure, mining, environment, heritage, nature, spatial planning and water management. This fragmentation leads to tuning and coordination problems and reduced recognizability and usability for all users. Initiators of activities are struggling with many different laws, each with its own procedures, plans and rules. Authorities assess an initiative not always in coherence and an integrated policy (set of rules) for one particular piece of the environment is hard to achieve. The proposed Environment Planning Act[2] integrates the area-specific parts of the current laws in one act with one coherent system of planning, decision-making and procedures.

The new environment planning act will ultimately integrate no less than 26 acts and parts of other legislations in one coherent act. Success of the environment planning act can only be achieved if and only if the legal rules of the Act can be successfully translated to the services of governmental organizations. A very realistic and timely case for our sustainable architecture!

In this section, we will introduce two typical cases of the environment act. These scenarios will introduce the different actors that play a role in the environment planning act:

- *Initiators* are parties that want to initiate a certain activity in the environment;
- *Affected parties* are parties that are affected by the proposed activity of the initiator. Affected parties could be neighbors or environmental stakeholders.
- *Authorities* are parties that have the power (Hohfeld) to create the legal situation in which the initiator is granted the liberty (Hohfeld) to initiate the activity, and corresponding the situation in which the affected parties are restricted by the no-right (Hohfeld) to interfere, but granted the power to go to court (case #1). Authorities also have the power to create rules by which first mentioned powers and liberties are restricted (case #2).

Case #1

"Bert" wants to open a restaurant. For the location of the restaurant, Bert has chosen an old building on a river dike at the border of a town in the municipality of "Rivierenland" (Riverland). Bert needs to rebuild and extend the building.

[2] At the time of writing of this article, the act is being discussed in the Dutch parliament. The current proposal can be found at: kamerstukken II 2014/2015, 33962, nr. A: https://zoek.officielebekendmakingen.nl/kst-33962-A.html.

The Act prohibits the activity of building, unless Bert has a permit which gives him the liberty[3] to build his restaurant (Article 5.1 under 1 sub a). Bert files a request for the permit with the authorities (according to Article 5.8: the executive board of the municipality Rivierenland).

"Hans" is a civil servant of the municipal of Rivierenland. He is authorized by the executive board to decide on requests for environmental permits in their name.

The activities for which Bert asks a permit are handled according to the "regular procedure" (Article 16.60). The core of this regular procedure is dictated by the rules stipulated in the general administrative act (Awb). The request of Bert is published so affected parties are informed of the activities that Bert wants to undertake.

Bert wants to build his restaurant, but also wants to make a playground in the area between the dike and the river. Hans informs Bert that this isn't allowed with respect to the environmental rules in place. Although Bert could file a request for just such an activity (Article 5.1 under 1 sub b), Bert chooses not to file such a request, but to postpone his desire for a playground.

"Annie" is a neighbor of Hans. Annie is concerned about the activities that Hans wants to undertake. Although Annie likes the idea of a restaurant, she doesn't like the idea of a long building period. She gets in contact with Bert. She shares her concerns, and Bert reassures her that it's also in his interest to have a short building period.

Bert has given Hans all the information that Hans needs to make his decision. Hans decides to grant Bert the permit, and thereby the liberty[4] to start building after the period in which affected parties can object against the decision of Hans.

Although Annie has the power to object against the decision of Hans, she has been reassured by Bert, and won't object. After a short building period, Bert opens his restaurant and welcomes Annie as a regular customer.

Case # 2

In the municipality of Rivierenland, Hans also takes part in the formulation of the environmental plan. In the current plan, the area between dike and river can only be used for the function of agriculture. But, more and more, requests are made to use this piece of land for different functions. It is decided that the environmental plan should change, to also allow the functions of recreational activities.

According to Article 16.28, this corresponds to the extended procedure, described by Section 3.4 of the general administrative act. In this case, the end result is not a particular right or duty of an individual civilian or organization, but the act of law in itself creates new rules. In this way, a fact at the scenario level will introduce a new

[3] The observant reader might notice that we use the Hohfeld categorization of rights and duties. This is actually another part of research done by the Blue Chamber, partly published in [5, 6, 7, 8, 14, 19].

[4] This is actually a simplified description of the legal rights that are the result of the permit. The permit not only grants Bert a liberty, but may impose certain duties, powers and other rights. Almost every legal act results in a complex of Hohfeld relations. This will be the topic of further study at the Blue Chamber.

rule and fact patterns at the regulation level. From case #2 we observe that not only legal facts are the result of certain brute facts, but actually all regulation is the result of certain brute facts. This needs further research.

9 Conclusions and Future Work

The case descriptions of the previous section make clear how the concepts of knowledge level II (as descripted by the articles of the environmental planning act) are linked with the concrete facts at knowledge level I (as descripted by the actors Hans, Bert and Annie, the acts they perform or want to perform, and the rights and duties that correspond with these acts). But it isn't by far a model that conforms to the requirements formulated in section 6.

The Blue Chamber has adopted the knowledge microscope principle. That means that the regulation is the primary object of study. This dictates which concepts are needed in a durable model. There is at the time of writing no single ISO, OMG or W3C standard modeling language that has the representational power required by the legality principle. Hence one needs a smart combination of various standards and of course some interfaces between the various standards. It is not to be excluded that the Blue Chamber will publish a proposal for such a standard language if ISO, OMG and W3C continue to fail to fill this gap. In other words, within the metaphor of biology: at a certain time in history, mankind thought that all matter was made up out of fire, earth, water and air [4]. This clouded their judgement with regard to the explanation of natural laws. After the discovery of the model in which matter is made up out of molecules that are made up out of elemental elements, the resulting descriptions of the characteristics of matter were more durable and sustainable. We propose a similar sustainable architecture that results in a durable model for services based on legislation. A model that is understood and accepted by all stakeholders, and rooted in a precise understanding of the semantics of legislation.

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References

1. Bouwman, H., van Houtum, H., Janssen, M., Versteeg, G.: Business Architectures in the Public Sector: Experiences from Practice. Communications of the Association for Information Systems **29**, Article 23 (2011)
2. Corbin, A.: Legal Analysis and Terminology. Yale Law School (1919)
3. Corbin, A.: Jural Relations and Their Classification. Yale Law School (1921)
4. Crosby, A.W.: The Measure of Reality: Quantification and Western Society, 1250-1600, 245p. Cambridge University Press (1997)
5. Dulfer, D., Lokin, M., Nijssen, S.: Developing and maintaining durable specifications for law or regulation based services. Paper Accepted at the FBM 2015 Workshop of the OnTheMove 2015 Conference, Rhodos, Greece, October 29–30. Springer (2015)

6. Engers, T.M., van Nijssen, S.: Bridging social reality with rules. Paper Presented at IRIS2014, Das Internationale Rechtsinformatik Symposion, Salzburg, Austria, February 21, 2014
7. Van Engers, T., Nijssen, S.: Connecting people: semantic-conceptual modeling for laws and regulations. In: Janssen, M., Scholl, H.J., Wimmer, M.A., Bannister, F. (eds.) EGOV 2014. LNCS, vol. 8653, pp. 133–146. Springer, Heidelberg (2014)
8. Engers, T.M., van Nijssen, S.: From legislation towards service development – An approach to agile implementation of legislation. Paper Accepted for Presentation at EGOVIS 2014, München, September 1-5 and to be Included in the Proceedings (2014)
9. Engers, T.M., van Doesburg, R.: First steps towards a formal analysis of law. In: Malzahn, D., Conceição, G. (eds.) eKNOW 2015, pp. 36–42. IARIA (2015)
10. Engers, T.M. van Doesburg, R.: At your service, on the definition of services from sources of law. In: Proceedings of the 15th International Conference on Artificial Intelligence and Law (ICAIL 2015), pp. 221–225. ACM, New York (2015)
11. Hart, H.L.A.: The Concept of Law, 3rd edn. Oxford University Press (2012). ISBN 978-0-19-964470-4 (First edition 1961)
12. Hohfeld, W.N.: Fundamental legal conceptions as applied in judicial reasoning. In: Cook, W.W. (ed.) (2010). ISBN-13: 978-1-58477-162-3
13. Lemmens, I., Pleijsant, J.M., Arntz, R.: Using fact-based modeling to develop a common language − A use case. Paper Accepted at the FBM 2015 Workshop of the OnTheMove 2015 Conference, Rhodos, Greece, October 29–30. Springer (2015)
14. Lokin, M., Nijssen, S., Lemmens, I.: CogniLex a legal domain specific fact based modeling protocol. Paper Accepted at the FBM 2015 Workshop of the OnTheMove 2015 Conference, Rhodos, Greece, October 29–30. Springer (2015)
15. ISO TR9007: Concepts and terminology for the Conceptual Schema and the Information Base, ISO Technical Report (1987)
16. Nijssen, G.M.: A Framework for Discussion in ISO/TC97/SC5/WG3, 78.09/01 (1978)
17. Nijssen, S., Valera, S.: An architecture ecosystem for the whole systems perspective, including system dynamics, based on logic & set theory and controlled natural languages. Working paper for the OMG Architecture Ecosystem SIG (2012)
18. Singer, J.W.: The legal rights debate in analytical jurisprudence from Bentham to Hohfeld. Wisconsin Law Review (1983)
19. Straatsma, P., Dulfer, D.: Wendbare Wetsuitvoering, DREAM 2014, The Netherlands (2014)
20. Thomson, J.J.: The Realm of Rights. Harvard University Press (1990). ISBN-0-674-74949-9