

# Validating Value Network Business Models by Ontologies

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**Keywords:** Business Model Canvas, e3value, ArchiMate, Ontology Integration, Meta-model, OWL, SPARQL.

**Abstract:** Different meta-models allow modeling the business of an organization from different perspectives. The Business Model Canvas focus is close to the strategy of the organization. E3value allows modeling of value networks and ArchiMate allows alignment from business models to IT infrastructure. When models of these three meta-models coexist for a certain value network, they must be consistent. Currently, there is no way to validate such consistency automatically. We propose a solution, using ontologies and ontology mapping techniques (OWL, OWL.DL, SPARQL) that helps to validate instantiated models automatically, based on a set of mapping rules between the three meta-models. In this work, the mappings between Business Model Canvas, e3value and ArchiMate are identified and formalized through ontologies. The formalized mapping is then applied to a case study and exploited, together with reasoning techniques.

## 1 INTRODUCTION

Innovative business models challenge the traditionally established ways of generating value, resulting in advantage to a company. We have seen, over time, that innovative business models can dare the subsistence of other established companies or even create complete new markets.

Having a shared understanding of what is the business model of a company, by representing it, eliminates possible interpretation ambiguities.

The Business Model Canvas (BMC) (Osterwalder & Pigneur, 2010) is a tool for representing the business model of a company. When a company is executing its business, it is part of a network of companies that exchange value with the final goal of delivering value to customers. e3value (Gordijn & Akkermans, 2003) allows modeling of value networks: the value exchanges between actors in the network.

BMC allows representing the business model of an organization on a higher-level (or strategic) perspective. e3value is closer to operationalization of business, by showing value transactions of the value network. On a lower-level, business processes can be modeled with ArchiMate (The Open Group, 2012), a service-oriented enterprise architecture modeling language, which considers three different layers: business, application and technology.

Toghether, these three meta-models allow the alignment from business models to information technology and infrastructure.

When modeling the business of an organization and its value network, several of these models can be instantiated. If they coexist for a value network, they must be consistent and there is no way to automatically validate such consistency between model components. We aim to analyze the possibility to perform this validation between models by using ontologies. An ontology is a formal, explicit specification of a shared conceptualization (Gruber & others, 1993). Such search for inconsistencies helps business to IT alignment.

In section 2, the research proposal is presented, and next, in section 3, we reference each meta-model. Afterwards (section 4), the mapping rules between the three meta-models are presented. In section 5, a validation has been done with an example case study. Finally, conclusions and future work are discussed.

## 2 RESEARCH PROPOSAL

As depicted in figure 1, a validation method for models of BMC, e3value and ArchiMate is proposed, based on a set of mapping rules between

the three meta-models and validation of those rules using reasoning techniques.

A formal representation is desirable in order to improve the meta-models conformance verification of models, through the verification of logical inconsistencies present in models. To define mapping rules between the meta-models is also required, in order to establish an alignment between the concepts of the meta-models that can assess the consistency between them. This proposal has a unified meta-model for the purpose of integration. Also, BMC, e3value and ArchiMate models will be instantiated in the integrated ontology. Ontology reasoning techniques will validate the correctness of the integrated ontology.

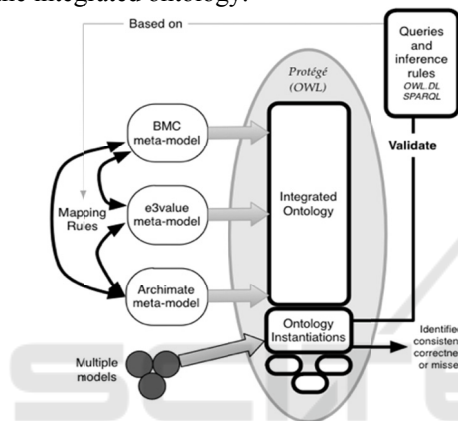


Figure 1: Research Proposal.

### 3 META-MODELS

In this section, the three meta-models used in this work (BMC, e3value, ArchiMate) are introduced.

The Business Model Canvas (BMC) (Osterwalder & Pigneur, 2010) aims to represent a business model and translate it into explicit knowledge by considering nine building blocks in a canvas. Its focus is close to a strategic perspective. BMC is based on the Business Model Ontology (Osterwalder & others, 2004).

E3value (Gordijn & Akkermans, 2003) enables value network modeling, aiming to provide a common understanding of a business idea executed by a network of actors that jointly create, distribute and consume value. A meta-model for e3value can be found in (Pombinho J. A., 2014).

ArchiMate is an open and independent modeling language, from the Open Group (The Open Group, 2012), The ArchiMate framework organizes its meta-model in a three by three matrix: the rows capture the domain layers (business, application, and

technology); the columns capture cross layer aspects (active structure, behavior and passive structure).

## 4 MAPPING RULES

To define the mapping rules, the meta-model mapping technique defined in (Zivkovic, et al., 2007) was partially applied. It distinguishes different types of mappings. On one level, we consider class-to-class mappings, which define relations between concepts of two distinct meta-models. On another level, we consider equivalence and aggregation mappings between concepts. The referenced technique is only used to define the mappings since we do not aim to merge ontologies.

### 4.1 Ontology Integration

The word integration has been used with different meanings in the ontology field. In simple terms, ontology integration is the process of identifying common concepts and relationships shared between ontologies, (Sofia & Martins, 1999) (Euzenat, et al., 2007). Three main techniques of ontology integration are categorized as:

- **Ontology Alignment:** the process of building a new ontology by identifying correspondences between all the concepts of two ontologies,.
- **Ontology Mapping:** the process of building a new ontology by finding common concepts between two (or more) concepts belonging to two (or more) different ontologies.
- **Ontology Merging:** the process of building a new ontology by merging several ontologies into a single one that will “unify” all of them.

Different types of mismatches may occur between different ontologies (Davies, et al., 2006) (Kotis, et al., 2006) (Amrouch & Mostefai, 2012) (Bouquet, et al., 2004):

- **Syntactic Mismatches:** if different languages represent ontologies.
- **Lexical Mismatches:** heterogeneities in names of entities, instances, properties or relations.
- **Semantic Mismatches:** classified into three abstract forms: (1) coverage, two ontologies that cover different (possibly overlapping) portions of the world (or even of a single domain); (2) granularity, two ontologies where one provides a more/less detailed description of the same entity; (3) perspective, two ontologies where one provides a viewpoint on some domain,

which is different from the viewpoint adopted in another ontology.

For mapping BMC, e3value and ArchiMate, there were two kinds of mismatches: lexical mismatch, where the same entity is represented by two different names, such as, Customer Segments and Business Actor; and coverage mismatch, where from the same point of view, in the same context and with comparable vocabulary, part of the domain that is described differs and there are only overlapping parts (Value Proposition and Goal). Most ontology mapping approaches focus on automating the discovery of a mappings. This case, requires an exact mapping, so the mappings were done manually using (Zivkovic, et al., 2007).

## 4.2 Mapping BMC to e3value

Previous work (Gordijn, et al., 2005) shows connections between concepts of BMC and e3value to understand similarities and differences between both ontologies to possibly integrate them in order to improve representation, design and analysis of business models. The defined mapping rules (*table 1*) are inspired on previous work.

## 4.3 Mapping BMC to ArchiMate

Another work (Meertens, et al., 2012) explored the connection between BMC an ArchiMate, where the concepts of BMC were successfully mapped to e3value. The defined mapping rules (*table 2*) are inspired on previous work. We do not consider any

mapping between Customer Relationships (CR) and Business Collaboration because CR refers to the types of relationships an organization maintains with its customers. Key Partners is only a list of partners, so the mapping is simplified to Business Actor. Cost Structure is not mapped to Value because it is only the cost of performing Key Activities and maintaining Key Resources.

## 4.4 Mapping e3value to ArchiMate

Direct transformation from e3value to ArchiMate is inhibited by different levels of abstraction between the economic transactions modeled in e3value and ArchiMate (de Kinderen, et al., 2012). The same authors use DEMO (Dietz, 2006) as a bridge for the different levels of abstraction of e3value and ArchiMate (de Kinderen, et al., 2012). Another work (Pombinho J. A., 2014) defines the mapping between e3value and DEMO in a more grounded, formal and thorough way. Namely, it specifies a detailed mapping based on the coordination acts and facts of the transactional pattern and the corresponding competences by the value actors. Additionally, the authors define a Value-oriented Solution Development Process in (Pombinho, 2013) that specifies a process for incrementally developing value networks by alternating coherent value and construction models. Table 3 shows the defined mapping rules.

Table 1: BMC-e3value meta-model concepts mapping.

| BMC concept       | E3value concept    | Mapping rationale  |
|-------------------|--------------------|--|
| Customer Segment  | Actor              | <b>Equivalence.</b> The Customer Segments are groups of people that a company aims to reach, while Actor is an independent economic entity that generates profit or increases its utility. (1:1)                     |
|                   | Market Segment     | Analogous to Actor. Market Segment is a specialization of Actor.   |
| Key Partner       | Actor              | <b>Equivalence.</b> Key Partners is the group of partners that help the businesses execution. Analogous mapping to Customer Segment. (1:1)   |
| Channel           | Value Transmission | <b>Aggregation.</b> A value transmission can be the delivery of value to customers through a certain channel. (many:1)   |
| Key Activity      | Value Activity     | <b>Equivalence.</b> Key Activities are the most important things a company must do to make its business model work, while an actor performs a Value Activity for profit or to increase its utility. (1:many)         |
|                   | Value Transmission | <b>Aggregation.</b> A Key Activity can involve a value exchange (to obtain a needed resource) with a Key Partner. (many:1)   |
| Key Resources     | Value Object       | <b>Equivalence.</b> A Key Resource acquired from a Key Partner. (1:1)  |
| Revenue Stream    | Value Transmission | <b>Equivalence</b> to inbound and monetary value exchange. (1:1)   |
| Value Proposition | Value Interface    | <b>Equivalence.</b> A value interface defines the group of value objects the company is willing to provide. Those value objects are also defined in the outbound value ports belonging to the value interface. (1:1) |
| Actor             | Actor              | <b>Equivalence.</b> The Actor concept is the owner of a BMC. (1:1)   |

Table 2: BMC-e3value meta-model concepts mapping.

| BMC concept       | ArchiMate concept           | Mapping rationale   |
|-------------------|-----------------------------|---|
| Customer Segment  | Business Actor              | <b>Equivalence.</b> Customer Segments are groups of people that a company aims to reach, while Business Actor is an organizational entity that is capable of performing behavior. (1:1)   |
| Key Partner       | Business Actor              | <b>Equivalence.</b> Key Partners is the group of partners that help the business model execution. Analogous to Customer Segments. (1:1)   |
| Channel           | Business Interface          | <b>Equivalence.</b> Channels describe how a company communicates with and reaches its Customer Segments to deliver Value Propositions. A Business Interface is a point of access where a business service is made available to the environment. (1:1) |
| Revenue Stream    | Value                       | <b>Equivalence.</b> Value may apply to what a party gets by selling or making available some product or service, or it may apply to what a party gets by buying or obtaining access to it. (1:1)  |
| Value Proposition | Business Service            | <b>Aggregation.</b> A Value proposition is a Business Service or a Product (1:many)   |
|                   | Product                     | <b>Aggregation.</b> The worth of the Service/Product for the Customer.  |
|                   | Value                       | <b>Aggregation.</b> Why the Service/Product is useful for the Customer.   |
| Key Activity      | Goal (Motivation Extension) | <b>Aggregation.</b> Why the Service/Product is useful for the Customer.   |
|                   | Business Interaction        | <b>Equivalence.</b> The performed Key Activities may be represented as high-level Business Processes or Business Functions, or by Business Interactions between internal Business Actors. (1:many)  |
|                   | Business Function           |   |
| Business Process  |                             |   |
| Actor             | Business Actor              | <b>Equivalence.</b> Analogous to Customer Segments, for example. (1:1)  |

Table 3: e3value-Archimate meta-model concepts mapping.

| E3value concept    | ArchiMate concept | Mapping rationale   |
|--------------------|-------------------|---|
| Actor              | Business Actor    | <b>Equivalence.</b> Actor is an independent economic entity that generates profit or increases its utility. Business actor is an organizational entity that is capable of performing behavior. (1:1)                    |
| Market Segment     | Business Actor    | <b>Equivalence.</b> Market Segment is a specialization of Actor. (1:1)  |
| Value Interface    | Product           | <b>Equivalence.</b> A value interface groups the value objects offering provided by one actor. Such value offering in concretized by business services and a Product is a coherent grouping of business services. (1:1) |
| Value Transmission | Business Service  | <b>Equivalence.</b> The utilization of a business service by an external actor is concretizes a value transmission. (1:1)   |
| Value Activity     | Business Process  | <b>Equivalence.</b> High-level business processes that support business services offered to external business actors. Business process choreography is only present in lower levels.                                    |
| Value Object       | Business Object   | <b>Equivalence.</b> A value object is a business object transmitted to some other actor. A business object is tangible. (1:many)  |
|                    | Value             | <b>Equivalence.</b> Value is the worth of a business service or product to some business actor. Value can represent intangible value objects. (1:many)  |

## 5 VALIDATION

This proposal has a unified meta-model for the purpose of integration. It was required to transform the three meta-models into ontology (OWL). The BMC OWL representation was obtained from other authors (Pigneur, 2004). The ArchiMate transformation process uses (1) an OWL representation of the ArchiMate meta-model and (2) OWL representations of ArchiMate models (Bakhshadeh, et al., 2014) (Antunes, et al., 2013) (Bakhshandeh, et al., 2013). An e3value OWL

representation was implemented with inspiration on the meta-model presented in (Pombinho J. A., 2014).

Figure 2, shows a partial of the integrated ontology, along with relationships with other concepts and some constrains. It was required to instantiate the models inside the integrated ontology as individuals (OWL). A transformation was made from BMC, e3value and ArchiMate example models to individuals.



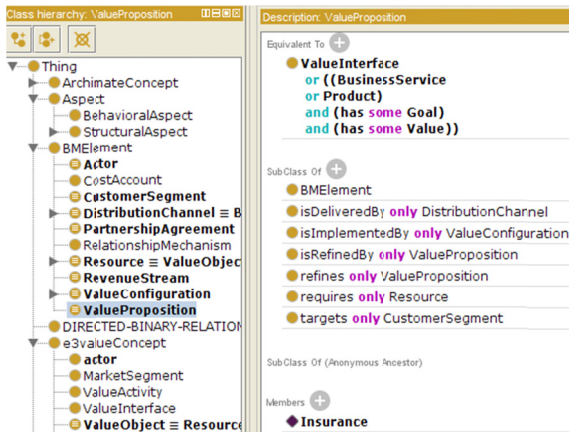


Figure 2: Partial OWL representation of the integrated ontology.

### 5.1 Case Study

ArchiSurance example models were used as a case study to analyze the current ontology. Example models have been taken from (The Open Group, 2012) (Meertens, et al., 2012), except for the e3value, in which a coherent simple model has been designed for the purpose.

The example models have been converted to the OWL to be represented as the instances of the integrated ontology. The example in this section is used to illustrate the capabilities of reasoning, by validating the correctness of the integrated ontology. A set of predefined competency questions (Fox & Gruninger, 1998) were used in order to validate ontology.

### 5.2 Reasoning

In the recent years logical reasoning has been widely used in the field of ontology engineering (Baader, et al., 2008) (Corcho, et al., 2006) (Lenzerini, et al., 2004). The set of competency questions defined to validate the integrated ontology is composed by the following questions:

1. What are the Value Propositions that have Value “Be\_Insured”?
2. What are the Key Partners of “Archisurance”?
3. What are the Value Propositions that have the Goal “Reduce\_maintenance\_costs”?

In figure 3 to 5, such questions can be formalized into a description logic queries. The first two queries are in OWL-DL and the last one in SPARQL .

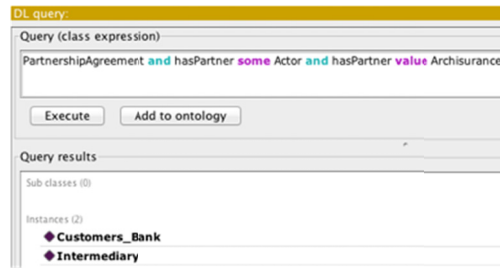


Figure 3: Query1 result.

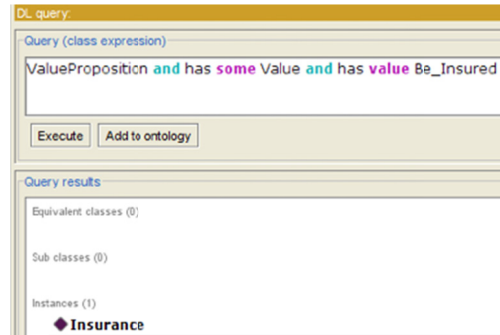


Figure 4: Query2 result.



Figure 5: Query4 result.

## 6 CONCLUSIONS

In this paper, we showed how to bridge between BMC, ArchiMate and e3value meta-models along with their models, by the use of ontologies and ontology mapping techniques.

An integrated ontology was created from the three meta-model ontologies and example models were instantiated into it. This integrated ontology was validated through a case study via logical reasoning techniques. The linkage between the three meta-models allows automatic consistency validation of models of the three meta-models.

Future work will focus on the application of this approach to new scenarios in order to explore the analysis possibilities, considering the usage of different reasoning and querying techniques.

## ACKNOWLEDGEMENTS

This project is partially supported by the European Commission under the 7th Framework Programme (FP7/2007-2013) under grant agreement 269940, TIMBUS project (<http://timbusproject.net>). Also, by national funds through FCT – Fundação para a Ciência e a Tecnologia, under project PEst-OE/EEI/LA0021/2013.

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