Formalizing an e-Business Model Ontology with XML, Xlink and XPointer

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Abstract
Conceptual modeling still has a large potential in the domain of implementing e-business strategies and business models that has yet to be realized. In this paper we explain how an ontological approach to e-business models can be the foundation for the development of a variety of tools that help companies create a "blueprint" for the realization of their e-business strategies. Additionally, this will allow them to better understand, measure, change and sometimes even play around with and simulate their business models.
The goal of this paper is twofold: to propose an ontology for e-business model and to demonstrate that XML, Xlink and Xpointer are good candidate for modeling this ontology.

1 Introduction

"Business model" is a buzzword with no commonly accepted meaning. As explained by Petrovic et al. [1], a business model *describes the logic of a "business system" for creating value, that lies behind the actual processes*. In this paper we use the following working definition for business models, which will serve as a starting point for the more rigorous and detailed e-BMO. *A business model is nothing else than a description of the value a company offers to one or several segments of customers and the architecture of the firm and its network of partners for creating, marketing and delivering this value and relationship capital, in order to generate profitable and sustainable revenue streams.*
We understand business models as the missing link between strategy and business processes. Often there is quite a substantial gap between these two "worlds". Strategy people position the company, define and formulate objectives and goals, whereas business process and information system designers have to understand and implement this information. In order to guarantee a smooth strategy execution, firms require a very clear communication of concepts between the implicated parties. This is where rigorously defined business models come into play. By using an ontological approach to e-business modeling, one could create a shared and common understanding of the domain and facilitates communication between people and heterogeneous and widely spread application systems [2]. As illustrated in figure 1 a business model is the conceptual and architectural implementation (blueprint) of a business strategy and

represents the foundation for the implementation of business processes and information systems.

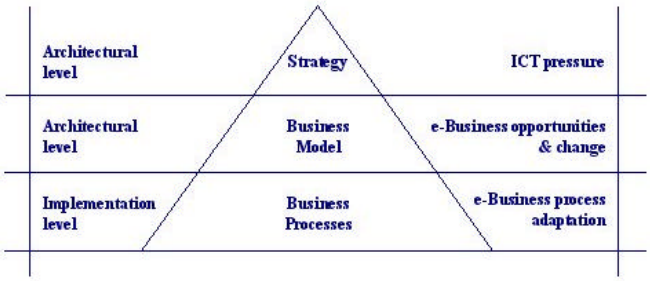

Figure 1. Business Logic Triangle

The use of formalized business models has the following advantages:

1. The process of modeling business models helps ***identifying*** and ***understanding*** the relevant elements in a specific domain and the relationships between them [3], [4].
2. The use of formalized e-business models help managers easily ***communicate and share*** their understanding of an e-business among other stakeholders [2]. This facilitates the exchange of business models between executives, but also with the people that design and implement business processes and Information Systems.
3. Mapping and using business models as a foundation for discussion facilitates ***change***. Business models designers can easily modify certain elements of an existing BM [1].
4. A formalized BM can help identifying the relevant ***measures*** to follow in a business, similarly to the Balanced Scorecard Approach [5].
5. BMs can help managers ***simulate*** businesses ***and learn*** about them. This is a way of doing risk free experiments, without endangering an organization [6]. Moreover, this helps companies prepare scenario planning [7].

But in order to achieve the advantages outlined above, firms must use a very rigorous approach to modeling business models. In the domain of e-business this becomes possible with e-BMO, which we describe in the next section in which we propose a definition and a framework; we outline the major advantages of a rigorous approach to e-business modeling. The third section consists of a sketch of our e-Business Model Ontology (e-BMO), which is a conceptualization of the relevant e-business issues and elements a firm has to think of in order to operate successfully in the Internet era. In the following section we formalize e-BMO with XML, Xlink and XPointer and describe the pros and contras of this approach. A list of possible applications of e-BMO is provided in the fifth section before concluding and outlining further prospects.

2 The e-Business Model Ontology (e-BMO)

The e-Business Model Ontology (e-BMO) is the conceptualization and formalization into elements, relationships, vocabulary and semantics of the essential subjects in the e-business model domain. e-BMO is structured into several levels of decomposition with increasing depth and complexity. The first level of decomposition of our ontology contains the four main pillars of a business model, which are the products and services a firm offers, the relationship it maintains with its customers, the infrastructure necessary in order to provide this and finally, the financial aspects, which are the expression of business success or failure (see figure 2).

Name of BM-Element	**e-BUSINESS MODEL ONTOLOGY (root element)**
Composed of	• PRODCUT INNOVATION • CUSTOMER RELATIONSHIP • INFRASTRUCTURE MANAGEMENT • FINANCIAL ASPECTS
Level of decomposition	0 (root element)

Description: An e-`BUSINESS MODEL ONTOLOGY` is *composed of* the `PRODCUT INNOVATION` element, the `CUSTOMER RELATIONSHIP`, the `INFRASTRUCTURE MANAGEMENT` and its `FINANCIAL ASPECTS`. These main elements are then further decomposed.

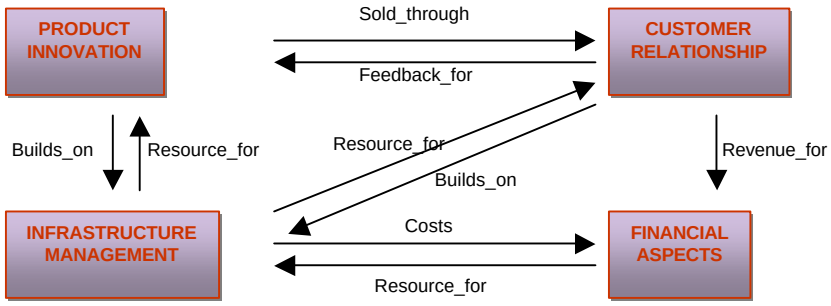

Figure 2. The 4 Pillars of the Business Model Ontology

2.1 Product Innovation

Name of BM-Element	PRODUCT INNOVATION
Child of	Root Element: Business Model
Composed of	• TARGET CUSTOMER SEGMENT • VALUE PROPOSITION • CAPABILITIES
Level of decomposition	1
Related to	• *Marketed through* CUSTOMER RELATIONSHIP: PRODUCT INNOVATION only represents a value for the firm when offered to customers with which the firm has established a relationship • *Based on* INFRASTRUCTURE MANAGEMENT: In order to provide the element PRODUCT INNOVATION, the firm has to maintain an

	INFRASTRUCTURE MANAGEMENT

Description: The PRODUCT INNOVATION element covers all aspects related to the offering of the firm. This comprises not only its products and services but the manner in which it differentiates itself from its competitors. In other words, this means not only the firms market scope [8], [9] - which customers, which geographical areas, and what product segments – but also the explanations why customers will rather buy from this firm than from a competitor. Moreover, the ability to offer value to a customer demands a range of specific capabilities.
The element PRODUCT INNOVATION is *composed of* the VALUE PROPOSITIONS the firm offers to specific TARGET CUSTOMER SEGMENTS and the CAPABILITIES a firm has to be able to assure in order to deliver this value. The outcomes of the PRODUCT INNOVATION element are *marketed through* the CUSTOMER RELATIONSHIP ELEMENT, which at the same time provides a source of *feedback for* product amelioration. PRODUCT INNOVATION is based on the INFRASTRUCTURE MANAGEMENT which provides a *resource for* it (see figure 2).
VALUE PROPOSITION. This element refers to the value the firm offers to a specific target customer segment. ICT has created many new opportunities for value creation on the one hand and more efficient value creation on the other hand [10].
TARGET CUSTOMER. A firm generally creates value for a specific customer segment. The definition of the market scope [8], [9] captures the essence of where the firm does and does not compete – which customers, which geographical areas, and what product segments.
CAPABILITIES. To deliver the value proposition to different customers, a firm must ensure that it possesses the range of capabilities that underpin the proposed value. Several authors describe how value and competencies or capabilities are interconnected [11], [12]. Capabilities can be understood as repeatable patterns of action in the use of assets to create, produce, and/or offer products and services to a market [12].

2.2 Customer Relationship

Name of BM-Element	**CUSTOMER RELATIONSHIP**
Child of	Root Element: Business Model
Composed of	• INFORMATION STRATEGY • FEEL & SERVE • TRUST & LOYALTY
Level of decomposition	1
Related to	• *Feedback for* PRODUCT INNOVATION: By analyzing the CUSTOMER RELATIONSHIP a firm can gain important insights on the use and appreciation of its products/services. • *Based on* INFRASTRUCTURE MANAGEMENT: In order to provide the element CUSTOMER RELATIONSHIP, the firm has to maintain an INFRASTRUCTURE MANAGEMENT

Description: Through the use of ICT firms can redefine and ameliorate the notion of CUSTOMER RELATIONSHIP. ICT supports and in some cases substitutes direct physical contact with the customer. The CUSTOMER RELATIONSHIP element

describes the way a firm goes to market and gets in touch with its customers. Additionally, it contains the strategies of the company to collect and use customer information, in order to improve relationships and adapt the firms offering to customer needs. Finally, the company must define and outline its plans to gain the customers trust and loyalty.

The element CUSTOMER RELATIONSHIP is composed of the FEEL & SERVE element, which defines the customer "touch points" (e.g. distribution channels), the INFORMATION STRATEGY for the collection and application of customer information and the TRUST & LOYALTY element, which is essential in an increasingly "virtual" business world. The CUTOMER RELATIONSHIP element *provides feedback for* PRODCUT INNOVATION and is *based on* INFRASTRUCTURE MANAGEMENT (see figure 2).

INFORMATION STRATEGY. The objective of the information strategy concerns information gathering in order to excel in customer relationship (e.g. through personalization and profiling). The information strategy aims at discovering new and profitable business opportunities and to ameliorate customer satisfaction. Data warehousing, data mining and business intelligence are important technologies that allow managers to gain insight on their customers buying behaviour. These insights can be used to create what Hamel [8] calls the positive feedback effect.

FEEL & SERVE (distribution channels). This element refers to the way a firm "goes to market" and how it actually "reaches" its customers [8]. This means a company must define its channel strategy : either indirect or direct channels, operated by the firm or provided by a third party (e.g. agent, intermediary). ICT, and particularly the Internet, has a great potential to complement rather than to cannibalize a business's channels [13]. Direct selling over the Web could improve margins, whereas selling through new Internet mediation services (cybermediaries) [14] could mean new market opportunities. Of course the expansion of the range of channels also increases the potential of conflicts between channels [15] and demands strong management.

TRUST & LOYALTY. It is essential to establish trust between business partners when the business environment becomes increasingly virtual and the implicated parties do not necessarily know each other anymore before conducting business. There exists mechanisms to build trust in e-business environments, such as virtual communities [16], performance history, mediation services or insurance, third party verification and authorization, and, clear privacy policies [17], [18]. Customer loyalty can be understood as the outcome of the customer's trust and satisfaction.

2.3 Infrastructure Management

Name of BM-Element	**INFRASTRUCTURE MANAGEMENT**
Child of	Root Element: Business Model
Composed of	• RESOURCES • ACTIVITY CONFIGURATION (or VALUE CONFIGURATION) • PARTNER NETWORK
Level of decomposition	1
Related to	• *Resource for* PRODUCT INNOVATION: The INFRASTRUCTURE MANAGEMENT element enables the creation of value for the customer.

	• *Resource for* CUSTOMER RELATIONSHIP: The INFRASTRUCTURE MANAGEMENT element allows a firm to establish and maintain a CUSTOMER RELATIONSHIP. • *Cost for* FINANCIAL ASPECTS: managing infrastructure and co-ordination activities has a certain cost.

Description: ICT and particularly the Internet have had a fundamental impact on the way companies organize their activities inside and at the boundaries of the firm. Not only that the company boundaries have become more fuzzy, but increasingly the decomposition and re-composition of the industry value chain has redistributed the activities among existing and new industry actors.
INFRASTRUCTURE MANAGEMENT describes the value system configuration [19] that is necessary in order to deliver the firms offering and to establish and maintain a customer relationship. It is *composed of* the ACTIVITY CONFIGURATION and the in-house RESSOURCES AND ASSETS and the firm's PARTNER NETWORK to fulfil these activities. The INFRASTRUCTURE MANAGEMENT element is a *resource for* PRODUCT INNOVATION and CUSTOMER RELATIONSHIP (see figure 2).
ACTIVITY CONFIGURATION. The main purpose of a company is the creation of value that customers are willing to pay for. This value is the outcome of a configuration of inside and outside activities and processes. To define the value creation process in a business model, we use the *value chain framework* [20] and its extension, such as defined by [21]: value shop and value network.
PARTNER NETWORK. The partner network outlines, which elements of the activity configuration are distributed among the partners of the firm. Shrinking transaction costs make it easier for firms to vertically disintegrate and to reorganize in partner networks.
RESOURCES. In order to create value, a firm needs resources [22]. Grant [23] distinguishes tangible, intangible, and human assets. Tangible resources include plants, equipment and cash reserves. Intangible resources include patents, copyrights, reputation, brands and trade secrets. Human resources are the people a firm needs in order to create value with tangible and intangible resources.

2.4 Financial Aspects

Name of BM-Element	**FINANCIAL ASPECTS**
Child of	Root Element: Business Model
Composed of	• REVENUE MODEL • COST STRUCTURE • PROFIT/LOSS
Level of decomposition	1
Related to	• *Resource for* INFRASTRUCTURE MANAGEMENT: The financial capacity of a firm allows it to maintain operations.

Description: The element FINANCIAL ASPECTS is the culmination of an e-business model. The best products and services and the finest customer relationship are only valuable to a firm if it guarantees long-term financial success.
The FINANCIAL ASPECTS element is *composed of* the companies REVENUE MODEL and its COST STRUCTURE, which finally define the PROFIT/LOSS of a

firm. This element is a resource for INFRASTRUCTURE MANAGEMENT and is funded through the sales in the CUSTOMER RELATIONSHIP (see figure 2).

REVENUE MODEL. This element measures the ability of a firm to translate the value it offers its customers into money and therefore generate incoming revenue streams. A firm's revenue model can be composed of different revenue streams that all have different pricing models. The new pricing mechanisms enabled by ICT should be used in order to maximize revenues. Particularly the Internet has had an important impact on pricing and has created a whole new range of pricing mechanisms [24].

COST STRUCTURE. This element measures all the costs the firm incurs in order to create, market and deliver value to its customers. It sets a price tag on all the resources, assets, activities and partner network relationships and exchanges that cost the company money.

PROFIT MODEL. This element is simply the outcome of the difference between revenue model and cost structure. Therefore it can be seen as the culminating point and as an expression of the entire e-business model ontology. Whereas Product Innovation and Customer Relationship shall maximize revenue, an effective Infrastructure Management shall minimize costs and therefore optimize the profit model.

3 Formalizing e-business models with XML

The e-BMO defines the business model concepts of an e-BM, their meaning and the relationships between them. It is the semantic level of formalizing e-business models. Although it helps managers easily communicate and share their understanding of an e-business model, it does not offer the way to automatically verify whether an e-Business model really respects the e-BMO constraints. To make e-business models exchangeable in a nonambiguous manner, we suggest to use the eXchangeable Markup Language (XML) [25], the Xlink [26] and the XPointer [27] standards.

3.1 Why XML ?

A multitude of XML consortiums and projects (xCBL, cXML, etc.) intend to rewrite the concepts of the aging Electronic Data Interchange (EDI) with XML syntax for business applications on the Internet [28]. One of the most important projects is the joint initiative of Organizations for the Advancement of Structured Information Standards (OASIS) and the UN's Center for Trade Facilitation and Electronic Business (UN/CEFACT). It focuses on enabling transactions across industries and businesses, particularly smaller companies, generally left out of EDI in the past [29].

But XML is not limited to transaction purposes and can serve a wide range of other goals. It is a metalanguage, which means that it is a standardizing format for describing structured information. This makes it ideal for our purpose of describing the e-BMO in a formalized manner. So eBML does not focus on the exchange of messages and e-business processes. eBML is situated at a higher level of abstraction: it will help to encode business models. A business model expressed in eBML is an XML document that respects the constraints and the rules imposed by the e-business modeling ontology e-BMO.

This formal representation and the multitude of existing tools to manipulate XML documents have a number of advantages. It becomes easy to verify the validity of a business model to the e-BMO. Different business models can be compared or can be evaluated to one another. Generating different views (such as specific documents) in function of different needs (such as descriptions, graphical representations, business plans, reports for financing, reports for eventual partners, acquisitions or mergers, etc.) becomes possible. The maintenance and the exchange of business models in heterogeneous IT environments and the construction and development of an ontology for e-business modeling expressed by an XML vocabulary becomes easy [30].

3.2 The e-business modeling language (eBML)

In this section we illustrate our purpose of e-business modeling with a case study in the photography industry named ColorMailer [31] (see figure 3), particularly for the `INFRASTRUCTURE_MANAGEMENT` component.

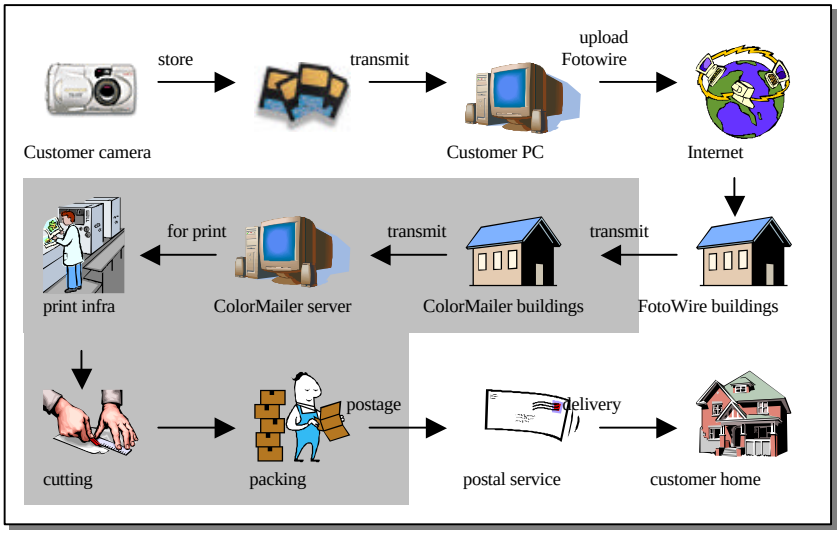

Figure 3. Infrastructure Management of Colormailer

The modeling vocabulary and composition rules of the eBML language is defined by an XML Document Type Definition (DTD); an XML schema is also available if needed. It is composed of elements that represent the concepts of the e-BMO and the relationships between them (principally hierarchical). An e-business model of a company is a valid XML document based on the eBML DTD. The description (or instantiation) of each concept is delimitated by an opening tag in the form of <concept> and a closing tag in the form of </concept>. An eBML document starts with the tag of the root element `<eBM>` and ends with the tag `</eBM>`. The subtree contains the four main components of the e-BMO which contain their respective subtrees defined in the eBML DTD. Listing 1 illustrates a part of the DTD followed by the global structure of an e-business model document.

Listing 1: A part of the eBML DTD and the global structure of an e-BM

```
<!ELEMENT eBM                          (PRODUCT_INNOVATION,
                                       CUSTOMER_RELATIONSHIP,
                                       INFRASTRUCTURE_MANAGMENT,
                                       FINANCIAL_ASPECTS)>

<!ELEMENT INFRASTRUCTURE_MANAGMENT     (RESOURCES,
                                       ACTIVITY_CONFIGURATION,
                                       PARTNER_NETWORK)>

<!ELEMENT RESOURCES                    (RESOURCE+)>


<eBM>
   <PRODUCT_INNOVATION>...</PRODUCT_INNOVATION>
   <CUSTOMER_RELATIONSHIP>...</CUSTOMER_RELATIONSHIP>
   <INFRASTRUCTURE_MANAGMENT>
      <RESOURCES> ...</RESOURCES>
      <ACTIVITY_CONFIGURATION>...</ACTIVITY_CONFIGURATION>
      <PARTNER_NETWORK>..</PARTNER_NETWORK>
   </INFRASTRUCTURE_MANAGMENT>
   <FINANCIAL_ASPECTS>...</FINANCIAL_ASPECTS>
</eBM>
```

We now detail the subtree of the INFRASTRUCTURE_MANAGEMENT element, which contains the subelements RESOURCES, ACTIVITY_CONFIGURATION and PARTNER_NETWORK (see above 3.3) In the example we illustrate this by the ColorMailer print infrastructure.
The first one of these three subelements contains a description of all in-house resources and assets the firm has decided to posses. The XML document will contain the name and description of every in-house resource between the <RESOURCES> and </RESOURCES> tags. If an individual access to each resource is needed, then we can assume that the metamodel defines a RESOURCES element which is a set of repeatable RESOURCE elements. These RESOURCES will allow the firm to fulfill a part of the activities and processes described in the ACTIVITY_CONFIGURATION element. This second subelement contains all general activities and processes necessary, in order to operate business and to provide value to the customer.
The third subelement of the INFRASTRUCTURE_MANAGEMENT element contains all partners and suppliers that represent out-house resources of the firm. The partners and suppliers fulfill all activities and processes that are not taken care of by the firm.

So the eBML definition of the Colormailer business model consists of the concatenation of all these elements preceded by the open tag of the INFRASTRUCTURE_MANAGEMENT element and followed by its closing tag. See listing 2.

Listing 2. The INFRASTRUCTURE_MANAGEMENT element of the Colormailer eBM

```
<INFRASTRUCTURE_MANAGMENT>
   <RESOURCES>
      <RESOURCE>
```

```
                a modern printing infrastructure from Agfa. With
                this equipment, digital images can be printed onto
                photographic paper, T-shirts and other items.
            </RESOURCE>
            <RESOURCE>
                15 people, who all work in an office in Vevey,
                Switzerland.
            </RESOURCE>
            <RESOURCE>
                The firm maintains its own Web servers, which host the
                Website and the downloadable transmission software.
            </RESOURCE>
            <RESOURCE>
                The image transmission takes place on the FotoWire
                Network.
            </RESOURCE>
        </RESOURCES>
        <ACTIVITY_CONFIGURATION>
            Printing images on physical material : This activity is an
            operation that consists of printing the virtual
            digital images on different physical materials, such as
            photographic paper, T-shirts and mouse pads.

            Digital Image Upload : In order to print digital images on
            physical items, this binary information must be transmitted
            to the production facilities over a network.

            operations consist of printing the digital information (binary
            images) onto different physical items. The inputs it needs to
            do this, mainly the bits and bytes of the digital photos, are
            uploaded to the firms production infrastructure via a suppliers
            network (even though the end-customer does not realize he is
            dealing with a third party)...
        </ACTIVITY_CONFIGURATION>
        <PARTNER_NETWORK>
            Outsourcing Digital Image Transmission : the image transmission
            network of FotoWire is shared with other similar companies.

            Outsourcing Transmission Software : FotoWire regularly updates
            and maintains the digital image upload and transmission
            software in order to stay state of the art.

            For home delivery of its products : the firm relies on the
            Swiss postal service.

            For Sales : it cooperates with its two main partners, Sony
            Europe and Interdiscount.
        </PARTNER_NETWORK>
    </INFRASTRUCTURE_MANAGMENT>
```

4 Why XLink and XPointer ?

In the previous section we explained how we modelize e-business model's components and the hierarchical relationships between them, in XML. But as shown in section 2, the e-BMO ontology also defines another kind of relationships :

principally cross-references. So an eBML document representing an e-business model will contain elements like PRODUCT_INNOVATION, CUSTOMER_RELATIONSHIP, INFRASTRUCTURE_MANAGEMENT and FINANCIAL_ASPECTS, but also links or relationships such as Resource_for, Sold_through, Builds_on, etc. (see figure 2). In this section we suggest to modelize the non hierarchical relationships of the e-BMO by links in the eBML according to the Xlink and Xpointer specifications.

Linking in XML is divided into two parts, XLink and XPointers. XLink, the XML Linking Language, defines how one document links to another document. But if all components of an e-business model are stored in the same eBML document, Xlink is enable to help as defining relationship between them. XPointer, the XML Pointer Language, help defining how individual parts of an e-business model are addressed. An XLink points to a URI (in practice, a URL) that specifies a particular e-business model. This URI may include an XPointer part that more specifically identifies the desired part or element of the targeted business model. Links do not even have to be stored in the same file as the documents they connect. These features make Xlinks more suitable for cross-references and interlinked data [32].

Xlink defines many types of links. They are represented by elements that have an xlink:type attribute which can take the value simple, extended, arc, etc. An arc element also has an xlink:from attribute and an xlink:to attribute. The xlink:from attribute says which element of the e-business model the arc comes from. The xlink:to attribute says which element the arc goes to. They do this by matching the value of the xlink:label attributes on the various resources in the extended link. For instance, if the xlink:from attribute has the value A, and the xlink:to attribute has the value B, then the arc goes from the resource whose xlink:label has the value A to the resource whose xlink:label has the value B. As usual the xlink prefix is associated with the http://www.w3.org/1999/xlink namespace URI. Listing 3 demonstrates. The Resource_for element defines an arc from the resource with the label "Infrastructure_Management" to the resource with the label "Product_Innovation".

Listing 3. An extended link with arcs

```
<Resource_for xmlns:xlink="http://www.w3.org/1999/xlink"    xlink:type="arc"
xlink:from="Infrastructure_Management"   xlink:to="Product_Innovation"/>
```

Inline links, such as the familiar <A> element from HTML, are themselves part of the source or target of the link. Generally, they link from the document that they're part of to some other document. However, they can also link to a different part of the same document. The source of the link, must be included inside the <A> element that defines the link. the author doing the linking must insert named anchors into the targeted document and this is not always possible. Extended links however, can be out-of-line. An out-of-line link does not contain any part of any of the components of the business models it connects. Instead, the links are stored in a separate XML document called the linkbase. Out-of-line links also allow to add links to and from documents that can't be modified. In the case of modeling e-business models, we can define a new business model just by creating a new linkbase that defines links

between specific components of many existing buiness models without modifing any of them. Most of the time we simply append the XPointer to the URI separated by a #, just as we do with named anchors in HTML. For example, the locations of the Infrastrucutre_Management and the Product_Innovation elements in the Colormailer business model could be suffixed its URL (http://inforge.unil.ch/sbellagh/eBML/colormailer.xml) and come out looking similar to the listing 4.

Listing 4. Exemples of Xpointer adresses

```
http://inforge...colormailer.xml#xpointer(/child::eBM/child::Product_Inn
   ovation)
http://inforge..colormailer.xml#xpointer(/child::eBM/child::Infrastructu
re_Management)
```

So the description of the `Resource_For` element, defining the relationship between the `PRODUCT_INNOVATION` and `INFRASTRUCTURE_MANAGEMENT` elements is as follows (listing 5).

Listing 5. Xlink and Xpointer definition of the Resource_For relashionship

```
<RELATIONSHIPS xmlns:xlink="http://www.w3.org/1999/xlink">

<COMPONENT xlink:type="locator" xlink:label="Product_Innovation"
xlink:href="http://inforge.unil.ch/sbellagh/eBML/colormailer.xml#xpointe
r(/child::eBM/child::PRODUCT_INNOVATION)"/>
<COMPONENT xlink:type="locator" xlink:label="Infrastructure_Management"
xlink:href="http://inforge.unil.ch/sbellagh/eBML/colormailer.xml#xpointe
r(/child::eBM/child::INFRASTRUCTURE_MANAGEMENT)"/>

<Resource_For   xlink:type="arc"   xlink:from="Infrastructure_Management"
                                        xlink:to="Product_Innovation"/>

</RELATIONSHIPS>
```

In many cases a predicate is necessary to pick the one element or concept from an element set that we want. So if we want to define a `Resource_For` arc link between the fisrt `RESOURCE` of the `RESOURCES` child of the `INFRASTRUCTURE_MANAGEMENT` and the `PRODUCT_INNOVATION` element, we must change the xlink:href value of the Component element as follows (see listing 6).

Listing 6. Another Xlink and Xpointer definition of the Resource_for relashionship

```
<RELATIONSHIPS xmlns:xlink="http://www.w3.org/1999/xlink">

<COMPONENT xlink:type="locator" xlink:label="Product_Innovation"
xlink:href="http://inforge.unil.ch/sbellagh/eBML/colormailer.xml#xpointe
r(/child::eBM/child::PRODUCT_INNOVATION)"/>
<COMPONENT xlink:type="locator" xlink:label="Infrastructure_Management"
xlink:href="http://inforge.unil.ch/sbellagh/eBML/colormailer.xml#xpointe
r(/child::eBM/child::INFRASTRUCTURE_MANAGEMENT/child::RESOURCES/child::R
ESOURCE[1])"/>

<Resource_For   xlink:type="arc"   xlink:from="Infrastructure_Management"
                                        xlink:to="Product_Innovation"/>
```

```
</RELATIONSHIPS>
```

5 Conclusion

Astonishingly, the tools that help decision makers to design, validate and communicate their business models are still scarce. This is why we argue that it would be interesting to think of a set of tools that are based on e-BMO.

The first tool we propose is e-BMO itself, which represents a conceptualization of the e-BM domain. It identifies the relevant issues and their relationships and therefore contributes to the understanding of the domain. Second, we think it is important to develop an e-Business Model Language (eBML), to facilitate the description, assessment, communication of business models. eBML defines the metamodel of the logical structure of an e-business model that is valid according to the e-BMO ontology. So each business model is nothing else than a valid XML document with a set of links. It can easily be transformed into several different formats and documents (business plans, graphical representations, reports for financing, documents for knowledge sharing, etc.) in function of different needs (mergers & acquisitions, redesigning business models, planning e-business processes, ensuring acceptance by stakeholders, etc.). Formalizing business models description with XML, XLink and Xpointer make it possible to take advantage of XML applications and tools for transforming, and reutilising business models, and even rapidly generating new ones by linking parts of different existing business models.

Further, one can imagine an e-Business Model Handbook (e-BMH), which consists of a Web interface that allows users to navigate in the e-BMO concepts and understand them. Also, the e-BMH could become a repository for numerous e-business case studies. A similar tool, the so-called MIT Process Handbook, by the Massachusetts Institute of Technology (MIT) exists in the domain of process modeling [33]. Another tool we propose is an e-Business Model Design Tool, which should help business model designers rapidly design, adapt, assess and critic e-business models. This tool essentially refers to the metaphor of the drawing table, where an architect assembles the different elements of a building. The last tool we propose is a sort of e-business model flight simulator based on e-BMO and system dynamics that could simulate e-BMS. Managers would gain important insights on their actions and would learn about their e-business models by playing around with them in a risk-free environment. Figure 4 illustrates a classification of these tools and applications.

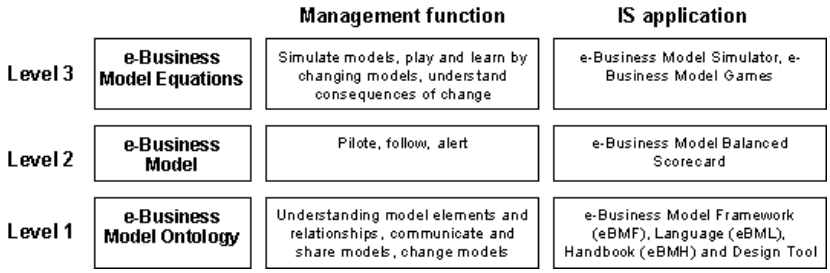

Figure 3. Applications of the e-business model ontology

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