TRANSCENDING TAXONOMIES WITH GENERIC AND AGENT-BASED E-HUB ARCHITECTURES

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Abstract: If effectively utilized, modern technologies such as ontologies and software agents hold the potential to inform the design of the next generation of E-Hubs. In terms of their evolution, we argue that taxonomies as tools hold the danger of stifling innovation as they may implicitly impose boundaries on the problem domain. We proceed to use one that is well-referenced in the literature and identify a number of issues that can be seen as limiting factors, proposing a generic and agent-mediated architecture that holds the potential of addressing them.

1 INTRODUCTION

E-Hubs bring together buyers and sellers in real-time trading communities at relatively low cost (Rosson, 2000). Taxonomies are classification systems that allow one to uniquely identify something. One of the best known examples is the science of systematics which classifies animals and plants into groups showing the relationship between each (Bishop et al., 1995). Any classification should be presented in such a form that stakeholders can use to specify the identity of the system they seek as a solution to a problem and to prescribe the base functionality that will guide the design. But taxonomies can also stifle innovation by limiting the views of the stakeholder, imposing boundaries through categorization schemes and levels of abstraction that can and must be challenged. In this work we take as a starting point a well-referenced taxonomy for E-Hubs (Kaplan et al., 2000) and identify a number of issues that demand our attention.

The next section contains the issues that drive our research towards the proposition of a generic E-Hub architecture which is presented in the third section. The paper concludes by presenting the next steps in our research endeavors.

2 E-HUB TAXONOMIES

Regarding the taxonomy in (Kaplan and Sawhney, 2000), we have put forward four issues that can be used for arguing against the underlying assumptions behind it and in effect question any claims to future applicability that it may have. **Issue 1:** Mougayar (2000), states that E-Hubs are not as open as they could or should be. Every company has different types of products and services and a different customer base to deal with. Even if they have the same product categories, they may present them differently to their clients emphasizing on special attributes that they only amongst the other hub participants choose to provide. In addition, the particular taxonomy differentiates E-Hubs to those that deal with manufacturing and to those that deal with operating products. Simply stated, if a company transcends these categories in the physical world, it cannot do it in the virtual. **Issue 2:** Virtually every hub or marketplace created focuses on either B2B or B2C business transactions. An integration of both categories would yield a generic e-hub made for all stakeholders across the process flows and covering every step of the way from production to consuming. It is important to note that the taxonomy proposed by Kaplan and Sawhney only covers B2B E-Hubs. **Issue 3a:** Categorizing E-Hubs as in the particular taxonomy may strip away any flexibility that a prospective participant could have used in order to evaluate his options to engage or not. In systematic sourcing the conditions are not favorable for small participants since they cannot achieve the same terms and discounts as large users who buy large quantities through the E-Hub. In spot sourcing the conditions are not favorable for large clients since even if they buy a lot from the E-Hub they sometimes during the auction may end up buying to a steeper price than a small business. Accordingly, an E-Hub offering both spot and systematic sourcing may help to avoid the

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appearance of phenomena that relate to the 'chicken-and-egg' problem. **Issue 3b:** Long-term contracts in current E-Hub systems are negotiated on fixed product prices. The negotiation schemes of E-Hub architectures offer no allowances regarding the users' wish and freedom in generating a new offer or have any influence over the "game rules". Again, an integration of both categories can help the user to be flexible to market dynamics and either harden or soften his/her negotiation stance to his advantage. **Issue 4:** According to (Kaplan et al., 2000), E-Hubs can be either neutral or biased. In the physical world there exists no such distinction. A business can be neutral to some and biased to others. Buyers as well as suppliers are needed for the system to function and neutrality can be decided according to the chosen tactics and strategies.

In the next section we propose a prototype of a generic and agent-mediated E-Hub architecture that was designed so as to confront the above issues perceived as impediments to the evolution of open and truly flexible E-Hubs. What we imply is that our research path followed probes us to question the applicability of existing taxonomies and revisit their underlying assumptions.

3 A GENERIC AND AGENT-ENABLED E-HUB ARCHITECTURE

To be effective in achieving their set objectives, E-Hub users must analyze a wealth of information, negotiate over multiple contracts, and execute a lot of complex transactions on the Internet (Kontolemakis et al., 2004). To this end, agents play a significant role and many systems such as those proposed by Debenham (2000) and Shen et al. (2002) are beginning to incorporate them in their architecture.

Agents are clearly identifiable solving entities with well-defined boundaries and interfaces and have evolved from Multi-Agent Systems (MAS).

The main areas related to E-Hubs where agent-based functionality can be applied are ontologies, advising services and negotiation. By ontology we mean the specification of the knowledge structures used to define concepts and the relationship among those. The primary focus when designing the ontology model of an E-Hub is to satisfy those design requirements that will enable its extension, share and reusability both within and outside the boundaries of the hub infrastructure (Albers et al., 1999). The advising service an agent is to deliver requires the consideration of a multiplicity of design issues and parameters such as *intent* (the goal of the advising agent), *timing* (when the agent generates advice), *intrusiveness* (how proactive the agent is in interrupting the user's workout), *presentation* (how the advice is displayed to the user), and *content* (the information the advice contains) (Chin-Ming Fu, 1997). Negotiation is the process by which a group of agents come to a mutually acceptable agreement (Jennings et al., 2001). In Figure 1, we show how the three basic components of an E-Hub come together and interact defining as a whole the functionality of the system. The first component is the Generic Product Ontology which is created so as to cover every possible product or input combinations which can be stored in the systems database. The second is the Negotiation Agent, who is responsible for managing the negotiation process between the buyer and seller using ontology attributes and for reaching a mutually acceptable promise which is then fulfilled through the logistics services. The third one is the Advising Agent, who uses the ontology to help the user to accomplish a specific task, keeping track of user movements and bringing together users that share common interests according to their profile.

A flexible and generic E-Hub architecture can mutate from one taxonomy classification to another. We have expanded and build upon the model presented in (Albers et al., 1999) so as to cover every aspect of a modern electronic hub whilst striving to keep it as simple and hence as reusable as possible.

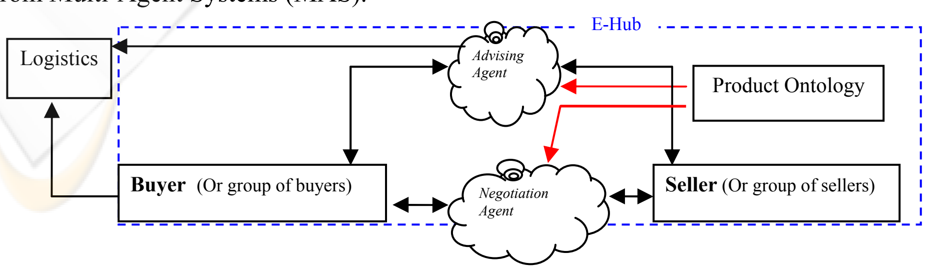

Figure 1: A Generic and Agent-Mediated E-Hub Architecture

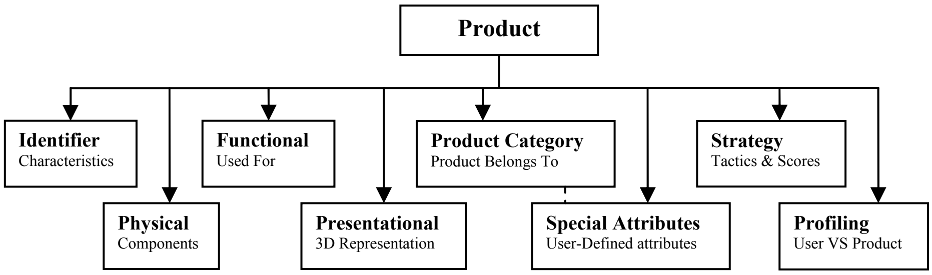

Figure 2: Generic Product Ontology

In Figure 2 the expanded product model is depicted. The **Identifier** is the ID along with some details for recognition of the product. The **Physical** property corresponds to a single material when we talk about manufacturing inputs or to a collection of raw materials or other products so that when synthesized an operating input is created. So both manufacturing and operating products are supported by the ontology (*issue 1*). The **Functional** property refers to the possible applications of the product. The **Presentational** property is related to the way in which the product is represented to the user (Albers et al., 1999). As described in (Niem, 1999), the latter is accomplished by creating a 3D model from images taken as inputs. The **Product Category** property provides the vendor with the ability to classify his product into a broader category. Each category is assigned with specific properties called Special Attributes. The **Special Attributes** property includes alternate characteristics or meta-attributes of a product. This property contributes to producing a flexible system since additional product attributes are not predefined by the ontology, but can be created at run-time by appropriately configuring the Product Category. In conjunction with the physical property it provides the flexibility to the user to promote his product or service in any way that he sees fit (*issue 1*). **Strategy** is a property that helps the user to define his deal-making tactics based on the products' negotiable attributes. **Profiling** is a property that allows one to define the characters of the people for whom the product will most likely have greater appeal.

According to the proposed architecture buyers can be sellers and vice versa as shown in Figure 1 by the fact that both buyers and sellers are part of the E-Hub. This means that an industry can buy raw material from the same hub that it later sells the final product. This integrates B2B and B2C E-Hubs in an open and generic platform that everyone can participate (*issue 2*). Taking into account that in manufacturing inputs quantity determines price, the ontology offering the Special Attributes property can accept ranged space attributes other than price, here quantity. In this way the E-hub supports both vertical and horizontal business purchases (*issue 1*). With the help of the Profiling attribute of the ontology and the agent implementing it, the spot sourcing oriented E-Hub can easily be mutated into systematic sourcing for a specific buyer (*issue 3a, 4*). This, for example, can be accomplished when the customer buys a lot from a) a specific seller that can provide him with better terms relating, for example, to price, and b) from not a specific seller but from the same hub where for example having met predefined sales levels, better prices quotes can be offered regarding fulfilment services, etc.

The advising agent keeps track of the buyers' movements and for the first case it informs the seller for the specific customer and proposes him to contract the customer with better terms. If the seller agrees, the discount is applied every time the two sides come to a mutually accepted agreement through negotiation (*issue 4*). This mechanism favours the vendor in the sense that he receives all the orders and the buyer in the sense that he enjoys better terms. If the contracts that take place consider a discount percentage on the upper or lower limit of the negotiation ranged space attributes and the negotiation is still used then the buyer will still receive lower prices. But if something unexpected happens causing the product's negotiable attribute (usually price) to rise, then the seller would have a chance to apply hard utility factors and functions on the product that will enable him not to loose money and to keep his client happy since he will still buy cheaper than the others (*issue 3b*).

For the second case, the advising agent informs the corresponding logistics department for the discount in shipping fees (sending them the reduced fee that should be retrieved from his/her account) as well as the buyer for the discount taken place. This favours the buyers since the E-Hub lowers its transaction/fulfilment costs. Sellers can also be favoured in this E-Hub. The advising agent keeping track of all the transactions within the marketplace can also decide whether a specific seller can enjoy a reduction in the rental space of the marketplace. This decision is taken by considering not only the value of the goods sold but also the frequency of sales. If the reduction is decided, the seller is informed and a new contract must be signed for the changes to take effect. So the proposed architecture could prompt us to classify it as neutral but offering at the same time the flexibility to become either forward, reverse and biased (*issue 4*).

Last but not least, the ontology of this E-Hub employs the ability of Reverse Aggregation since many buyers can join together as one, to accomplish better terms. We believe that when only reverse aggregation is employed by an E-Hub it is unlikely to have all buyers as possible customers. With the architecture mentioned above, even if Reverse Aggregation is employed, large purchasers can enjoy better terms on their own without having to ally with other smaller purchasers. The element client (C) is embodied in the hub without any vitiation of the B2B procedure (*issue 2*). So, everyone can participate in this E-Hub (*issue 2*). This can be again accomplished by the advising agent, who can match sellers or buyers according to their profile and bring them together to form a group of sellers or a group of buyers. If this group is formed, it is then treated as a single buyer or seller and can enjoy better terms according to the aforementioned contracts.

4 CONCLUSIONS AND FURTHER RESEARCH

Taxonomies are tools that can be used to classify objects and thus, implicitly or explicitly, impose a frame around the problem domain addressed by research. We argue that although such framing can be useful for guiding research by narrowing the boundaries of the domain, they should also be approached with caution since any such restrictions may stifle innovation. Taking such a taxonomy as a starting point, we have identified a set of issues that to our opinion are obstacles to the evolution of modern E-Hubs and proposed an architecture that addresses them.

Our research falls under the design-science paradigm in information systems research where knowledge and understanding of a problem domain and its solution are achieved by engaging in the actual process of building the desired artifact and applying or putting it into use.

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