Policy-based Management for E-Service Delivery

Giacomo Piccinelli[*], Cesare Stefanelli[+], Michal Morciniec[*], and Marco Casassa Mont[*]
[*]*Hewlett-Packard Laboratories, Bristol (UK)*
[+]*University of Ferrara (Italy)*

Abstract

If the first chapter of the Internet was about the dissemination of information, chapter two is about services. In the past, the Internet strategy of a company was about using a web site for advertising products. Today, companies shift their focus on electronic services (e-services), and the Internet offers a ubiquitous platform to support e-service deployment and provision. In particular, electronic marketplaces represent the new space for service providers and service consumers to interact and carry out business transactions. Trust becomes a central issue in electronic business relationships, and its enforcement is a fundamental value that electronic marketplaces can offer to their members.

The paper focuses on trusted contract enforcement for e-service delivery in the context of a second-generation infrastructure for electronic marketplaces. In particular, it describes the model and the application prototype for mediated e-service delivery developed at the HP labs in Bristol. The presented solution is based on the concept of dynamic enforcement for delivery policies deriving from contractual agreement between service provider and service consumer.

Keywords: e-services, electronic marketplaces, electronic contracts, e-service delivery, service-level policies

1. Introduction

If the first chapter of the Internet was about the dissemination of information, chapter two is about services. In the past, the Internet strategy of a company was about using a web site for advertising products. Today, companies shift their focus on electronic services (e-services), and the Internet offers an ubiquitous platform to support e-service deployment and provision. Electronic marketplaces (e-marketplaces) and e-services are among the main drivers of the Internet evolution, from both a business and a technology perspective.

E-services are about business assets made available over the Internet to drive new revenue streams and to create new efficiencies. E-marketplaces are the virtual context where to find the match between the customers' demand for services with the set of service offers. The process of negotiation between service consumer and service provider produces a contract that captures and formalises the agreement between the parties. The contract embeds the rules for the interaction between service consumer and service provider. As it happens in normal business contexts, service delivery follows contract acceptance by both parties.
Negotiation and contract formation tend to follow standard patterns, largely independent of the traded services. The automation of the negotiation process is therefore relatively easy, when compared to service delivery and contract enforcement. It is not uncommon for existing e-marketplaces to support negotiation and contract formation, while contract enforcement is usually beyond their scope and technical capabilities [Blo00]. Second-generation e-marketplaces will progressively take on the role of trusted mediators, to validate the actions of the parties against the agreed contract [Gip99]. In the basic version of the model, the parties drive the interaction and the mediator just monitors its consistency. Extensions of the model define a more proactive role for e-marketplaces in the orchestration of the parties.

In the context of the second-generation e-marketplace developed at HP Labs, this paper presents a model and its implementation for mediated e-service delivery based on the concept of externalisation of business interaction processes. After an overview of e-marketplaces, e-services, and e-service lifecycle, the paper discusses the trust issue in e-marketplaces with respect to e-service delivery. Then it presents a

mediation model for e-service provision, together with the description of the E-Service Shield (ESS) component and a simple example to clarify its use. Directions for ongoing and future developments follow.

2. E-Marketplaces and E-Services

The notion of e-marketplace derives from the aggregation of a number of integrated business services, enabled and delivered via the Internet [Blo00]. E-marketplaces operate in the open sourcing and traditional supplier market space. The model behind e-marketplaces aims to facilitate the purchase and sell of products, the purchase and deployment of software, and the interaction with professional services companies, financial institutions, and Internet service providers [Bar99, Rei97].

An e-marketplace is generally managed by an independent third-party organisation, usually referred to as e-market maker, that determines its characteristics (e.g. membership, regulations, service offer). E-market makers are business-to-business re-intermediaries that operate in the supply chain in various vertical [Fer00] and horizontal [Rug99] industries, with the aim of introducing new efficiencies and new ways of selling and purchasing products and services [Tim98]. An e-market maker provides content, value-added services, and often (but not always) e-commerce capabilities.

E-marketplaces are currently built by using technologies marketed by organisations such as Ariba, CommerceOne, TRADEX Technologies, BusinessBots, Trading Dynamics, Moai, etc [Blo00]. These companies sell products that provide information publishing tools, catalogue software, business process workflow features, transactional capabilities, auction capabilities, transcoding capabilities for multiple standards and formats, transaction and payment services, and customer relationship management functionality. Vendors of the enabling technologies usually employ a business model based on a combination of software licensing, custom consultancy, and installation services, and, significantly for traditional software vendors, on transaction fees for the goods and services negotiated [Lie99]. E-market makers employ business models based on advertising revenue, subscription fees, and/or transaction fees.

The evolution of the Internet platform is pushing also for the improvement of e-marketplace infrastructures in order to support e-service delivery. In particular, HP is promoting the e-services initiative as a new paradigm for e-commerce. E-services can complete tasks, solve problems, or conduct transactions. E-services can be used by people, businesses, and by other e-services and can be accessed via a wide range of information appliances [HP99]. Almost any asset can be turned into an e-service and offered efficiently via the Internet to drive new revenue streams. In this scenario, successful companies will be those capable of turning their assets into e-services delivered via the Internet. We will see more and more companies offering e-services, in order to leverage not only their core business offerings, but also their proprietary processes, data, relationships, knowledge, and experience.

E-services will be available on web sites, but others will be delivered via TV, phone, pager, car, email in-box, or virtually anything with a microchip in it. Some will even operate behind the scenes, automatically working on behalf of consumers and providers. In such a heterogeneous environment there is a clear case for interoperability, which industry and academic consortia are facing by proposing several standards in many different areas [Shi00].

3. Trust Issues in E-Marketplaces

The e-marketplace plays a crucial role as a rich source of business opportunities, and in the consolidation of business relationships. Key value offered by e-marketplaces is an extended group of potential business partners. Companies either offering a service or requiring a resource can post in the e-marketplace the information that becomes immediately available to customers and suppliers on a global scale. Trust is a pervasive requirement for the service model and infrastructure of the e-marketplace.

The focus of the first generation of open e-marketplaces is almost entirely on competitive pricing. Referring to the lifecycle of a business transaction, the support offered to the members of an e-marketplace is mainly in terms of advertising and negotiation, with a wide range of auction-based mechanisms for trading goods and services, but with very limited support for other aspects, such as contract definition. This requires companies to maintain internally a complex and expensive infrastructure for handling the contractual and post-contractual phase of transactions. Moreover, dealing with a dynamically changing set of business partners stretches to the limit the capabilities of existing business administration systems. The price advantage hardly translates into extra profit as hidden administration costs erode profit margins.

The relation between trust and efficiency is very well appreciated in the business world. For example, the operational structure of a company is built around a positivistic approach; any production unit concentrates on fulfilling a received request in the best possible way rather than questioning (within obvious limits) why the request arrived in the first place. This is the working assumption behind business process engineering and workflow management systems. The energies spent in the initial definition of processes and procedures can increase the efficiency in the execution phase. This is also the working assumption of companies in a business partnership; after the definition of the business relationship (possibly captured in a contract), a company expects its partners to adhere to the agreement without having to check everything all the time.
While sound business practices are pillars for long-term relationships, open e-marketplaces push for the dynamic creation of business partnerships with previously unknown companies, with possibly a low level of trust. In other words, the trust element deriving from long-term relationship is weakened, and the control measures that companies may have to consider can substantially erode the overall benefits of using e-marketplaces. The model and related infrastructure components presented in this paper aims to guarantee the behaviours of participants in a business transaction.

4. Role of Electronic Contract

Business transactions carried over the Internet carry higher lever of risk due to the difficulty in determining the identity of trading partners and an opportunity for repudiation. The opportunity for repudiation arises because a business partner may try to avoid his contractual commitments by claiming that a given electronic document transmitted has not been received, has not been properly formatted or does not conform to agreed business rules. There is no solution to this problem but following a set of guidelines [ABA] can reduce the risk. For any contract obligation the partners are required to store data that can be impartially interpreted after completion of the transaction.
Electronic contract contains a number of obligation statements that define the condition under which the state of obligation arises as well as constraints on actions [ZML] agreed between the parties and the data pertaining to the action. Evaluation of the constraints determines if the obligation can be considered as fulfilled or violated. In order to facilitate conflict avoidance contracts also specify the sanction that will be prescribed if the obligation is violated.
Typically e-service interface is specified using a form of a flow language that makes explicit action sequencing and public data exchanged between prospective business partners. When a contract if formed the constraints are added to the specification of the expected flow of interaction as well as alternative execution flows are added that define how sanctions will be carried out.
Given a trusted third party that mediates the interactions between contract parties and an agreed set of declarative contract statements it is possible to limit the transaction repudiation risk and hence enhance trust between parties. Although contract validation (checking if obligations are adhered to) is possible enforcement of contract (forcing parties to carry out their obligations) is very difficult in open marketplaces due to the ease with which an identity can be obtained. Indirect enforcement mechanisms such as reputation service [DEL] combined with message mediation are currently investigated that could facilitate self-regulated environment in which contractual behaviour is adhered to by the participants.

5. Lifecycle of an E-Marketplace Mediated Interaction

E-marketplaces can be involved in all stages of the lifecycle of an end-to-end transaction. An e-marketplace infrastructure should provide the support services and tools required for the provision of e-services, from their advertising, through their negotiation, to their actual delivery. This section outlines the contribution that e-marketplaces give to a business transaction.

- **E-service advertising**. The e-marketplace is the virtual place where service offers and requests are stored and made available to the members. Advanced directory services or automatic pattern matching facilities are the main mechanisms provided by the e-marketplace infrastructure.
- **Negotiation**. In addition to basic pattern matching between offer and demand, the e-marketplace can provide support for different types of negotiation processes. Beyond the initial contact, the objective is to provide support for all the interaction leading to the formation of a mutually satisfactory contract between the parties [GBW98]. Common market mechanisms involved at this stage are auctions, exchanges, catalogues, and RFQ (Request for Quotes). In addition to basic

price-related parameters, there are other important issues related to payment procedures, delivery processes, and service level agreement [Bar99].

- **Contract management**. The negotiation process produces a contract that captures and formalises the agreement between service consumer and service provider. The rules for the interaction between parties mainly derive directly from this legally bounding agreement. The e-marketplace support to the definition and formalisation of the electronic contract is considered a critical issue [MB95]. The trustworthiness of the e-marketplace has a strong impact on the level of involvement the parties are willing to accept in terms of mediation, and on the level of control the parties impose to each other.
- **Service delivery**. Usually neglected by first-generation e-marketplaces, a more direct involvement in the contract execution and service-delivery phase is the focus of second-generation e-marketplaces [Rei97]. Acting as a trusted entity, the e-marketplace can guarantee that both parties involved in the e-service transaction respect the agreed contract. To this purpose, the e-marketplace can exploit a monitoring component to control the interaction, but a more active role in the business interaction processes should be considered [MPT99].
- **Accounting**. In its role of trusted mediator, an e-marketplace is required to perform several operations also after the actual delivery of the e-service and the conclusion of the contractual relationship between the parties. The information collected about the behaviour of the companies; together with service-level related data are the basis to prepare the profiles of market members.

Second-generation e-marketplaces, such as the one developed at HP Labs, provide infrastructure-level support for all the phases of the business transaction lifecycle.

6. Mediated E-Service Delivery

An e-service encapsulates the overall business activity behind the delivery of a product (good or service) to a customer. For example, in the case of the sale of freight space there are specific business processes dealing with the collection of the goods, the exchange of the appropriate paperwork, the flow of notifications between the sender and transport provider, payment procedures, and so on. The e-service model requires the representation for the whole interaction process between service provider and service consumer to be in a format automatically tractable. The interaction process can be captured and formalised in the electronic contract, and the parties can map it on their internal processes in order to satisfy their contractual commitments (Figure 1). Information about financial history, customer/supplier rating, brand, and other forms of credentials represent an important added value for the negotiation process within e-marketplaces. In addition, we propose to extend the mediation role of e-marketplaces to the execution aspects of the e-service delivery contracts.

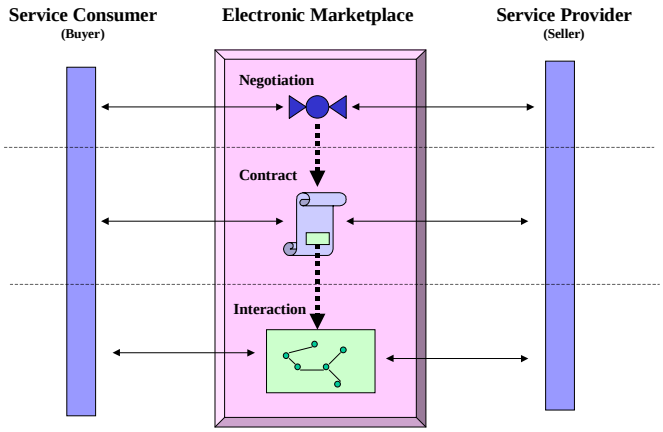

Figure 1. Mediated cooperation model

In terms of business interaction processes, two main aspects to consider are process flow and data flow. The process flow specifies aspects like the sequence and causal order for the interaction activities between the parties. Following the freight example, the process flow may indicate that only after receiving the notification from the customers that goods are ready for collection the transport provider has to collect them. The interaction can evolve along parallel threads and adapt to external requirements. While the goods are travelling the transport provider can be required to inform the customer of potential delays, as well as sending standard progress reports. Depending on the service options purchased the customer may or may not be entitled to ask for certain type of reports, or the reports can be requested only at specific stages of the service. The request for payment is possible only if the invoice has been sent.
Closely interdependent with the process flow, the data flow involved in a business interaction relates to the actual data exchanged in the various steps of the process. The focus is on document types and possibly on the actual content of the documents. The assumption is that the documents are in electronic format, or at least that an electronic description is available. Back to the example, notification messages might need a specific formatting [ebX, Ros]. Raising the level of complexity, the amount filed in the invoice has to contain the same value as the pay filed in the bank order.
The e-service model promises to be very powerful in terms of automation of the end-to-end transaction, but the implementation of the model requires some considerations. Despite the flourishing technologic and standardisation activities around e-services and related paradigms, it is not reasonable to expect companies to reconvert their ERP (Enterprise Resource Planning) and administration systems in the short term. As it happened for commercial web sites, e-service technology will have to be deployed on top of existing business information systems. An extra layer of protection and service management provided by a trusted e-marketplace can simplify operational models and technical infrastructure required internally by the companies.
Companies can clearly benefit from the offloading to a trusted e-marketplace of the interaction processes management, once agreed at contractual level. The initial effort for the definition of the agreement and the reliance on a trusted e-marketplace to enforce it can streamline the internal structure of the company.

7. The ESS Mediation Component

HP Labs developed a prototype of a second-generation e-marketplace with novel features for the specification, composition, deployment and management of e-services. The prototype has been designed according to the layered architecture depicted in Figure 2.
The lower layers (communication and execution) provide the reliable and scalable distributed processing environment for supporting the communication and the execution of distributed e-commerce transactions in the Internet open and not-trusted environment. These layers are present also in traditional first-generation e-marketplace infrastructures and are implemented with the most advanced off-the-shelf software products.
The service management layer provides advanced service and process management facilities. In particular, it provides a cluster of Web facing services, with Web servers and related technologies, together with some advanced functions like membership management (e.g. authentication, profiling) and service-session management. In addition, the process manager represents an innovative component that is considered critical for business-level solutions in the e-commerce space, where the interaction among businesses is substantially process-driven, and process management becomes the foundation for electronic management of contractual agreements. Process management in the HP prototype is realised by the HP Changengine component [HP00].
The solution management layer is the highest one in the HP infrastructure and provides advanced facilities for second-generation e-marketplaces, namely service composition, negotiation support, and contract management. The service composition engine defines, retrieves, and orchestrates the group of service providers required to satisfy a specific service request, well beyond one-to-one matching capabilities. The negotiation engine extends basic auction-based price optimisation, and encompasses complex contractual issues (e.g. delivery process, service-level agreements). As outcome of the negotiation, the contract manager provides the explicit management for electronic contracts and business relationships. In fact, the electronic contract captures the network of relationships deriving from commitments made by (possibly several) service providers.
All the components in the solution management layer of the platform have to cooperate, and this fundamental requirement has a deep impact in terms of their design and implementation. For example,

negotiation is driven by the requirements coming from the service composition engine. Similarly, the composite solution depends on the capability to find (through negotiation) the required service components. HP Labs have developed several specific technologies for all three areas [Cas00][MPT99], and the focus of this paper is on the mediation capabilities of the system. The component in charge of the mediation activity is E-Service Shield (ESS), in the service management layer.

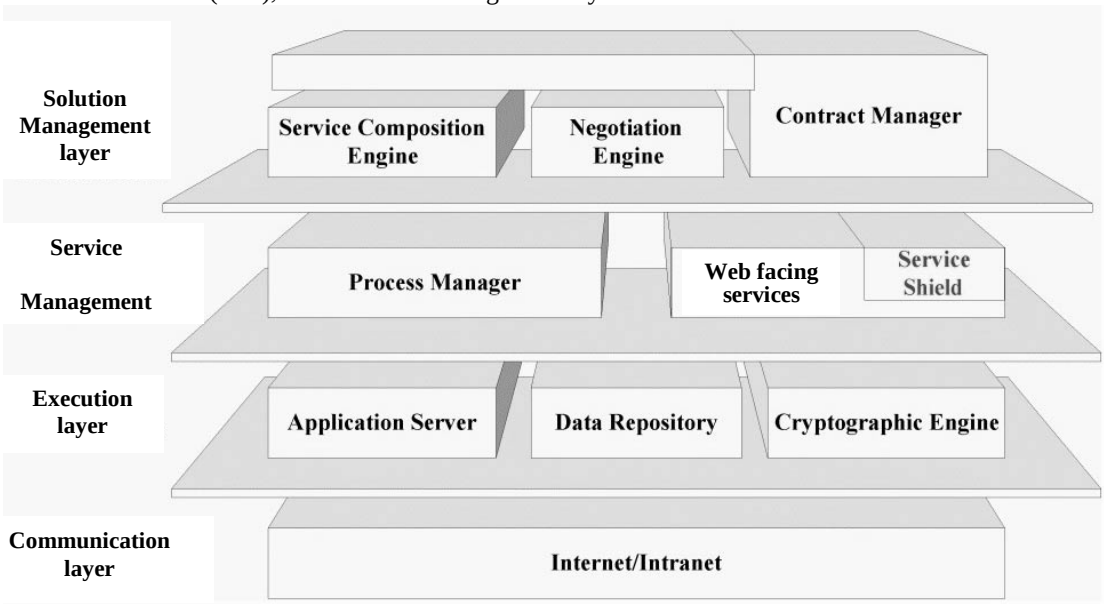

Figure 2. The architecture of the HP second-generation e-marketplace

The purpose of the ESS component is to support the enforcement of the contractual agreement between companies in terms of interaction processes. The contractual communication flow between service providers and service consumers goes through the e-marketplace, which acts as a trusted third party. The first version of ESS is mainly reactive, and focuses on the verification that a specific request for communication is valid with respect to the stage of the service delivery process at which it appears. For example, an invoice can be sent to the customer only after he has sent the purchase order. The parties can be confident that incoming requests are controlled by ESS and are compliant with the contractual processes they agreed upon. The ESS infrastructure also helps companies to prevent the propagation of internal mistakes to business partners (e.g. duplicate invoices, incorrect notifications, undue payment requests).
The internal architecture of the ESS component sees a Java application sitting on top of a policy-based authorisation server (called ACSIS [CBG00]), and connected with the process management capabilities of HP Changengine [HP00]. The specification of the service-dependent interaction process is based on XML, as it is for the service-class policies. A service-class policy can express for example the fact that in the context of catalogue browsing, the user requiring some details needs to qualify as having purchase power (see the following section).

Policies are deployed in the authorisation server, and they are referred to in the steps of the interaction processes deployed in the process manager. When the data exchanged in the process steps are formatted in XML (e.g. using RosettaNet-like protocols), dataflow verification is enforced at type level. Content-level verification is technically possible, but the full impact of this capability requires deeper analysis. Multi-signature and multi-digest techniques can be used for managing different levels of visibility of the business data exchanged. The level of trustworthiness inspired by the specific e-market maker is probably the basis on which business people will decide the data to expose.
The core mediation infrastructure provided by ESS exploits a fine-grain monitoring component that allows for different views of the interaction flow. The information collected can be fed into standard reporting systems (Figure 3), but the main use is currently for the member rating functions in the e-marketplace.

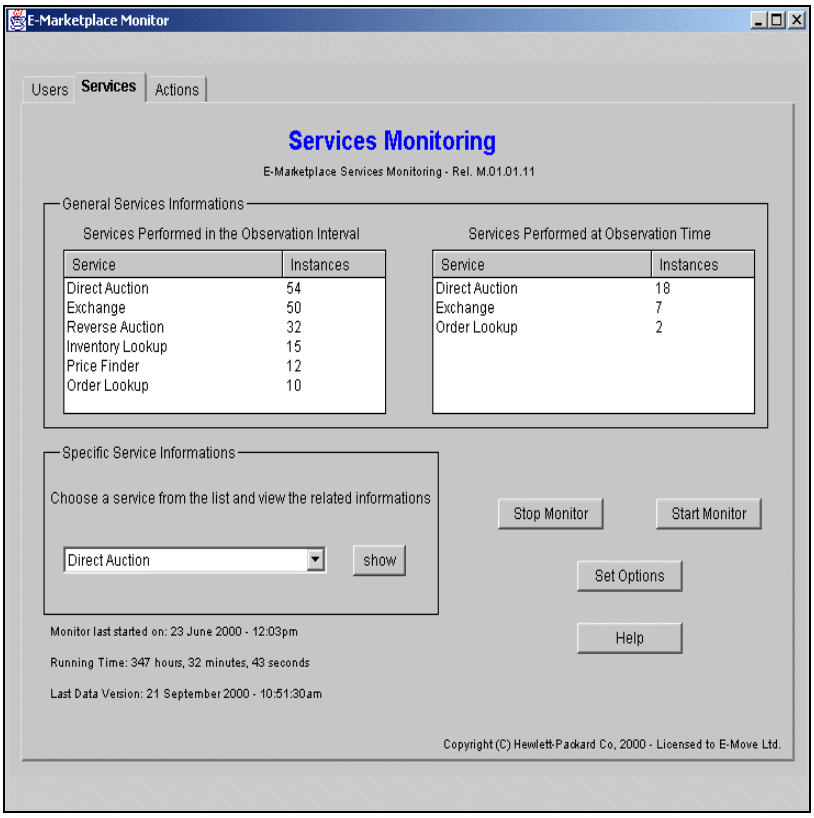

Figure 3. The e-marketplace monitoring user interface

8. Using the ESS Component

To describe the impact of the ESS component on business transactions, let us introduce an example in the context of catalogue-based sale of physical goods. The chosen example is from a traditional context, in order to show the impact that the ESS component would have even on simple e-services.
Figure 4 contains a section of the XML document that describes the specific part of the process with the rules of interaction for catalogue browsing. In particular, when the customer requires an information page, the seller has to provide both the data concerning the product and a sale offer. The customer can then decide to accept the offer, in which case it will have to send both an acceptance notification and a purchase form. However, the customer can decide to decline the offer, but it has to send explicit notification of the fact. The whole procedure has been negotiated in the form of a contract. In this particular case the service “CatalogueBrowsing” was probably offered to the customer at no cost, provided it accepted to comply with the interaction processes proposed by the seller.

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE process SYSTEM "interaction.dtd">

<process name="CatalogueBrowsing">

  ….

<sequenceProcess name="sequence13">
      <action name="action131" authorisation=”Catalogue- DetailsSelection”>RequestPage</action>
      <parallelProcess name="parallel132">
          <action name="action1321" authorisation=”Catalogue-SendSaleInformation”>Send_Page</action>
          <action name="action1322" authorisation=”Catalogue-SendSaleInformation”>Send_Offer</action>
       </parallelProcess>
       <orProcess name="or133">
            <parallelProcess name="parallel1331">
```

```
            <action name="action13311" authorisation="Catalogue-DetailsSelection">Accept_Offer</action>
            <action name="action13312" authorisation="Catalogue-DetailsSelection">Purchase_Form</action>
          </parallelProcess>
          <action name="action1332" authorisation="Catalogue-DetailsSelection">Decline_Offer</action>
      </orProcess>
</sequenceProcess>

…

</process>
```

Figure 4. Interaction process in ESS

In more detail, the action names (e.g. Send_Offer) in a process node are references to data structures called action cards. An action card contains three types of information related to the specific action: user notification, data type, and content constraints. The user notification is a description of the action itself that is provided to the user in order to understand the other two parts of the information in the node. The content can be a human readable description or some sort of action code for use in automatic systems. This information is added to the business data if the request is valid, and the whole structure is sent to the intended receiver. If the request is not valid, the information on user description is returned to the sender of the message. The information on data type gives indications on how to validate the XML structure of the message. The slot for content constraints can be used to capture conditions to be evaluated on the content of the message itself. The constraint specification language supported by the current version of ESS has been kept very basic, but an extension based on XQL is under development.
The attribute name in the process node contains internal references used by the execution infrastructure. The attribute authorisation is instead the link with service-class policies, and the ACSIS authorisation server [CBG00]. Service-class policies embed service-independent authorisation rules associated to the execution of a process step. In our example, the details of the rule Catalogue-DetailsSelection are presented in Figure 5. The first part of the name is actually an indicator of the library the policy belongs to. The policy itself specifies the constraints that the user has to satisfy. The constraints are defined in terms of the information the authorisation server can gather from different components of the e-marketplace infrastructure. In the example, the authorisation server gathers information from both the connection manager and user profiler. As an aside, the fact that a service-class policy can be reused in different context raises the problem of naming. In Figure 4 we can see how the name "DetailsSelection" policy is of no immediate association with action names.

```
 <Service>
     <ServiceName>Catalogue</ServiceName>
….
     <Functions>
     <!--.....FUNCTION DETAILS_SELECTION.....-->
        <Function>
        <FunctionName>DetailsSelection</FunctionName>
         <Conditions>
          <!-- WHO can use DetailsSelection -->
          <Condition>
             <ConditionContent>
                <![CDATA[CONTEXT.hasRole("customer")]]>
             </ConditionContent>
          </Condition>
          <Condition>
             <ConditionContent>
                <![CDATA[CONTEXT.hasAuthenticationLevel("financial-action")]]>
             </ConditionContent>
          </Condition>
         </Conditions>
        </Function>
….

     </Functions>
 </Service>
```

Figure 5. Action-level policy in ACSIS

9. Related Work

The relevance of electronic contracts to e-service provision has triggered a number of initiatives in both academia and industry [MB95]. Main points of interest regard contract specification, contract lifecycle, and contract execution. Contract specification is usually approached from a very pragmatic angle. Initiatives such as ebXML and RosettaNet [ebX, Ros] adopt a bottom-up approach, and starting from message-oriented ontology they are moving up towards the formalisation of cooperative business processes. In terms of electronic contract lifecycle, the COSMOS platform well exemplifies the type of requirements that management infrastructures have to meet, especially in order to support the contract formation phase [GBW98]. Process management emerges as central, both in the formation and execution phase of the contract. Focusing on contract execution, Open Flow, Cross Flow, and RABBIT exemplify how different assumption on the service provisioning model impact on the infrastructure requirements [SBF00], [KWA99], [MPT99].
The above-mentioned initiatives present many similar features at different levels (e.g. service model, architectural choices), but the central role played by processes is the main common theme. The need for automatic support to business interaction processes is a key issue for second-generation e-marketplaces [Gip99].

10. Conclusion

Trust is both an issue and a source of opportunities for e-marketplaces. The speed of electronic transactions, the broad space of potential business partners, and the potential for price optimisations are just some of the motivations that attract businesses to e-marketplaces. Still, the absence of the proper level of trust between the members of an e-marketplace can dramatically impact on the benefit they can achieve. Trust-related services become crucial components of any e-marketplace infrastructure.
In the scenario of the second-generation e-marketplace developed at HP Labs, the paper proposes a simple model for mediated service provision involving the e-marketplace in the role of trusted third party. The model is based on specific views of the business processes underpinning service provision, and active mediation of the communication flow between service providers and service consumers. The electronic contract captures the business interaction processes between the parties, and the ESS infrastructure component enforces the compliance between contractual agreements and the behaviour of the companies. The paper discusses the position of ESS in the HP e-marketplace infrastructure, and it describes also the main architectural choices related to the ESS component implementation.

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