Designing Service Negotiation Entities for the Electronic Market-place*

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ABSTRACT

The emergence of service providers and brokers who are independent of network providers has opened the way to a spot market in free network resources: it is under everybody's eyes that market enabled service provision based on Service Level Agreements (SLAs) will be essential for the delivery of many services such as *bandwidth on demand*. In order for those services to be created, configured and delivered dynamically via automated SLAs, a market enabling mechanism is required that is sufficiently flexible to convey the varying information requirements of the various stakeholders involved in the service delivery chain, together with their internal processes. In this paper an innovative framework for the negotiation of services with quality assurances is presented. The study is conducted keeping an eye on the latest standard proposals coming from the electronic business research community, with respect to both the modeling methodology and the actual design for implementation.

Keywords

E-Commerce, Service Assurance, Software Design

1. INTRODUCTION

The motivation to deploy new services as quickly as possible is based upon a provider's intention to secure its revenues. Providers are already operating on very thin margins, therefore it is hard to underestimate the importance of dynamic service provisioning and configuration in the current world of telecommunications. With the ongoing convergence in next generation IP networks of voice and data, control and management [1], the task of dynamic service creation is an extraordinary challenge.

The solution we envision relies on a systemic treatment of business, service and network layer issues, thus bringing to the introduction of three different models: Business Model (who is selling what to whom), Service Model (what and how gets delivered in service phases), network Resource Model (what and how is consumed in the network at the time the service is provisioned). Interaction between business, service and network layer entities is based upon a novel communication paradigm exploiting the concept of *mediation*. We use mediation as a generic term for a combination of negotiation, brokerage and state notification, jointly coordinating and configuring service components.

Though the problem formulated above is of a technological nature, the approach taken in this work is strongly 'business process driven': we identify a relevant business model, which has an impact on the whole architecture for service assurance. While designing such a model (roles, entities, actors, processes) we have taken into account relevant approaches from the Tina-C, Tele Management Forum (TMF) [2] and GII [3], which use the concepts of business roles and actors (stakeholders) [4].

In this paper we will expand on the issues related to the above defined Business Model. Assuming at the outset that a Qos capable network is available at the resource layer, we will see how flexible software management tools and protocols may help optimize the dynamic service negotiation process. This will shade light on how it is possible to reduce the unavoidable semantic gap between the user's and the provider's perception of the concept of a service.

The paper is organized in five sections. Section 2 will help position this work, by providing the main concepts and definitions. Section 3 proposes a model for the interaction between the main components of the proposed architecture for service assurance. An overview of the operation of such components in the electronic market-place is presented in section 4. Finally, section 5 provides some concluding remarks, together with information concerning our future work in this field.

2. MAIN CONCEPTS AND DEFINITIONS

The general architecture model we consider is based upon a user-provider relation, which allows for a customer to make requests and to obtain the requested services. A business

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oriented role that is crucial for our architecture is that of the *Retailer*. It provides customers with bouquets of services, offering them a front office that can be used for both service usage and service management. Thus, the business role level is devoted to customer care (front office, customer management) and is organized upon a market scheme (enterprise, residential, medical markets). Retailers act as a bridge to the service role layer, whose services are used for bouquets of services composition. Separation between customer and services is a key point in this architecture.

Summarizing the above concepts, the scenario we consider is sketched in figure 1. As shown in the picture, we refer to the negotiation of a service between a generic user and a value-added service provider (herein called the *Service Mediator*), via interaction with a novel entity, called the *Access Mediator*, which plays the role of the aforementioned *retailer*.

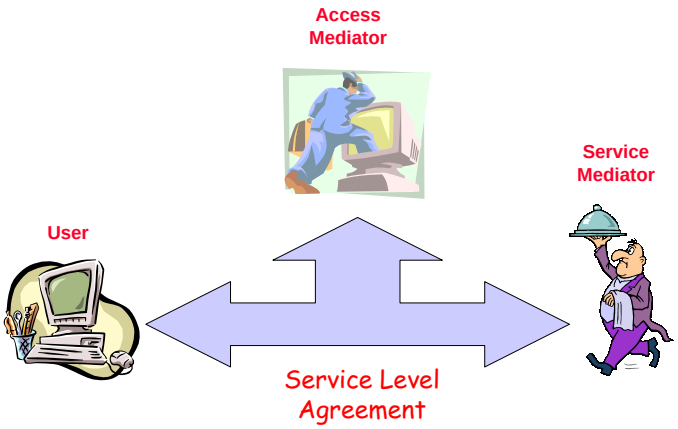

Figure 1: SLA-based service negotiation

The Access Mediator is the device into which users input their requests to the system. It adds value for the user, in terms of presenting a wider selection of services, ensuring the lowest cost, and offering a harmonized interface: the Access Mediator presents to the user the currently available services. The source of the services is a so-called Service Directory database, but the Access Mediator performs processing of the raw information. For example, in the case of a Video on Demand service, it can select the cheapest offer if a movie is available from more than one service provider, and it can notify the user as soon as a new movie becomes available that matches the stored user's profile. Its main role thus consists in assisting and easing the service selection process. This functionality may be under the control of a trusted third party and appears to offer excellent novel opportunities for a value-added service provider.

The Service Directory is a distributed Web-based information registry of services. It provides a way to publish and discover information about the specific business functionality exposed by one or more Service Mediators for the purpose of enabling the Access Mediator to negotiate and purchase a specified service. Generally off-line, the Service Mediator will supervise the incorporation of new services, their presentation in the Service Directory and the management of the physical access to these services via the appropriate underlying network. It is the task of the Service Mediator to prepare the SLA for the user to sign. It has an important role, as this is the place where services are created and from where the impacts of service reconfigurations are communicated to the network resource management system.

In this context, an SLA is a contract between the customer and the provider of a specified service. Such a contract is signed upon subscription to the service itself. An SLA is prepared from templates specifically conceived for the available services. SLA templates are used during customer negotiation to define the required level of service quality. The production of an SLA template is an intrinsic part of service development. SLAs are defined on something perceived by the customer (i.e. explicitly subscribed to), that is the service elements composing the service product offering.

3. AM-SM INTERACTION AS A BUSINESS PROCESS

This section draws a model for the interaction between the Access Mediator and the Service Mediator as a Business Process.

To the purpose, we exploit the emerging UN/CEFACT Unified Modeling Methodology (UMM) [5], that is gaining more and more importance in new generation Electronic Data Interchange (EDI). UMM helps strike the balance between the complexity of the processes under investigation and the need for accuracy in the way they are described: it definitely represents a powerful means to gain a common understanding of the domain, so to derive the high level requirements needed to effectively support the following phases, from detailed analysis to actual implementation.

The main use cases which model peer-to-peer interaction between the AM and the SM are presented in figure 2.

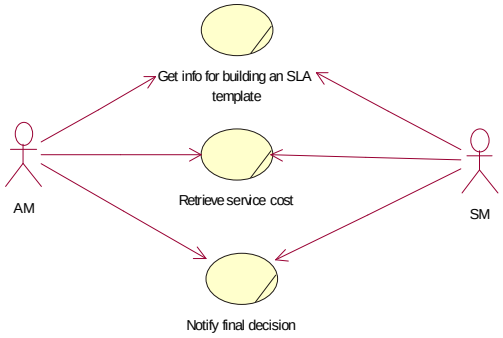

Figure 2: Use Cases related to AM-SM interaction.

In the *"Get info for building an SLA template"* use case, the AM asks the involved SMs (i.e. those which are currently offering a specified service) the details of the service. Picking up again the Video on Demand (VoD) example, such a use case would relate to the SMs sending their movie list back to the AM, as shown in the activity diagram in figure 3

The *"Retrieve service cost"* use case refers to the AM asking the SM the cost associated to a specified service instance. The activity diagram related to this use case is shown in figure 4.

Finaly, in the *"Notify final decision"* use case, the AM sends to the SM either a 'commit' or a 'rollback' message,

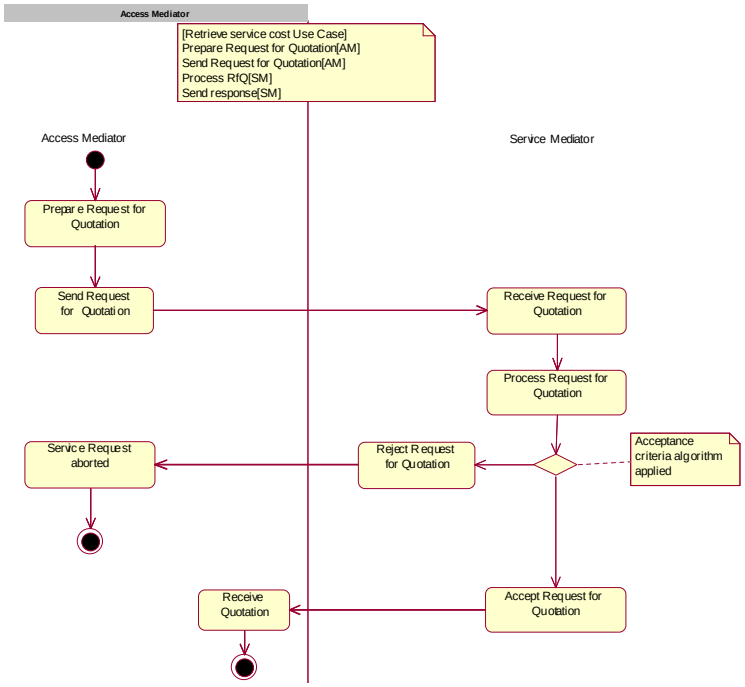

Figure 3: Get info for building an SLA template: activity diagram.

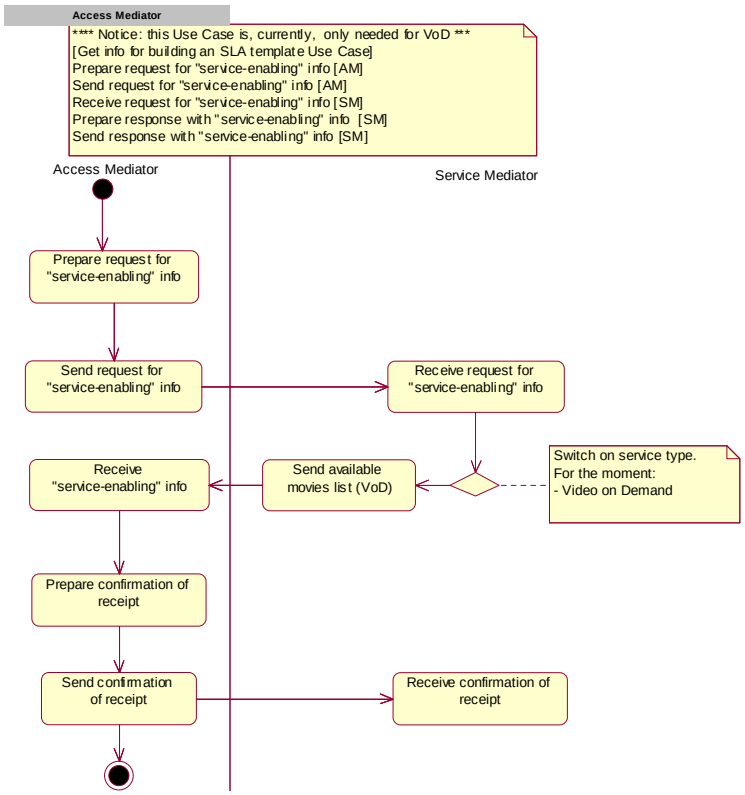

Figure 4: Activities performed in the Retrieve service cost use case.

depending on whether the SM's offer has been accepted or not.

The activity diagram related to this use case is shown in figure 5

4. THE MEDIATION COMPONENTS IN THE ELECTRONIC MARKET-PLACE

In this section we show how to exploit the concepts and methodologies typical of the emerging e-commerce frameworks in order to implement the mediators' interaction paradigm.

We will first introduce the *ebXML (XML for the electronic business)* proposal, which is gaining more and more attention in the international set; then, we will discuss how such a framework has been applied to the implementation of the business model which regulates the interaction between the Access Mediator and the Service Mediator.

4.1 ebXML

The vision of ebXML is to create a single global electronic marketplace where enterprises of any size and in any geographical location can meet and conduct business with each other through the exchange of XML based messages. In a few words, the aim of ebXML is to enable anyone, anywhere, to do electronic business with anyone else.

In order for enterprises to conduct electronic business, they must first discover each other and the products and services they have to offer. They then must determine which business processes and documents are necessary to obtain those products and services. Afterwards, they need to find out how the exchange of information will take place and then agree on contractual terms and conditions. Once all of this is accomplished, they can finally exchange information and products/services according to these agreements.

The architecture enables companies to work together in order to specify business processes, discover each other, negotiate collaboration agreements, and execute the processes defined.

The ebXML technical architecture [6] is comprised of two basic components. The Design Time component mainly involves Business Process and Business Information Analysis: it deals with the procedures for creating an ebXML application, as well as discovering and enabling resources required to carry out business transactions. The Run Time component covers the execution of an ebXML scenario with the actual associated ebXML transactions.

The Design Time artifacts enable the Run Time systems to execute the agreed business processes. Business processes and business documents are defined during the Business Process and Business Information Analysis activity. The Business Process Specifications for the defined Business Processes and Business Documents are stored and registered in Business Libraries, which contain catalogs of Business Processes and Business Information Objects. These catalogs reside in ebXML compliant registries/repositories. The business process modeling results in an ebXML Business Process Specification, which may be referenced in the Collaboration Protocol Profiles (CPPs) and forms the basis for Collaboration Protocol Agreements (CPAs) established between business parties. Ultimately, the business processes specified in the CPAs drive the business service interfaces to execute those processes and send the required documents.

Business process models specify processes that allow business partners to collaborate. By means of an appropriate modeling activity, it is possible to identify business processes and business information *meta models* that can likely be standardized. A Business Process describes in detail how trading partners take on roles, relationships and responsibilities to facilitate interaction with other trading partners in shared collaborations. The interaction between roles takes place as a choreographed set of business transactions. Each business transaction is expressed as an exchange of electronic Business Documents, which may in turn be composed from re-usable Business Information Objects.

4.2 AM-SM interaction Design Time Component

Having introduced the main concepts behind the ebXML architecture, we will now present their application to the mediation framework. More precisely, we will describe in the following the process that brought us to the definition of the Design Time component related to the specification of the interaction between the Access Mediator and the Service Mediator.

From a high-level perspective, the interaction between the Access Mediator and the Service Mediator may be seen as a single binary collaboration (see Fig. 6), made of a Business Transaction Activity (*RequestForServiceEnablingInfoBTA*) and a Collaboration Activity (*QuotationCA*). The former is needed to retrieve service enabling information, whereas the latter refers to the quotation phase (which, in turn, is to be followed by either the *Order* phase or the *Cancel Quotation* phase).

```
<BinaryCollaboration beginsWhen="SM List Available"
  name="NegotiateAndQuoteCO">
    <InitiatingRole name="Access Mediator"/>
    <RespondingRole name="Service Mediator"/>
    <BusinessTransactionActivity
       businessTransaction="RequestForServiceEnablingInfoBT"
       fromAuthorizedRole="Access Mediator" isConcurrent="false"
       isLegallyBinding="false"
       name="RequestForServiceEnablingInfoBTA"
       toAuthorizedRole="Service Mediator"/>
    <CollaborationActivity binaryCollaboration="QuotationCO"
       fromAuthorizedRole="Access Mediator" name="QuotationCA"
       toAuthorizedRole="Service Mediator"/>
    <Start toState="RequestForServiceEnablingInfoBTA"/>
    <Transition fromState="RequestForServiceEnablingInfoBTA"
       onInitiation="false" toBusinessState="QuotationCA"/>
    <Success fromBusinessState="QuotationCA"/>
    <Failure fromBusinessState="QuotationCA"/>
</BinaryCollaboration>
```

The *QuotationCO* Collaboration (see Fig. 7) may in turn be split into a Business Transaction Activity (*QuotationBTA*) and two mutually exclusive Collaboration Activities (*OrderCA* and *CancelQuotationCA*). The *QuotationBTA* activity is related to the actual quotation phase; after a quote has been received from the Service Mediator, either a purchase order activity or a cancel quotation activity are performed, depending on whether or not such a quotation is the one that the end-user selected.

```
<BinaryCollaboration name="QuotationCO">
<Documentation> The "QuotationCO" collaboration  starts with a
    QuotationBTA business transaction activity and then reuses
    either the Order collaboration or the CancelQuotation
    collaboration. This reflects the commit/rollback issue in
    the original model
</Documentation>
<InitiatingRole name="Access Mediator"/>
```

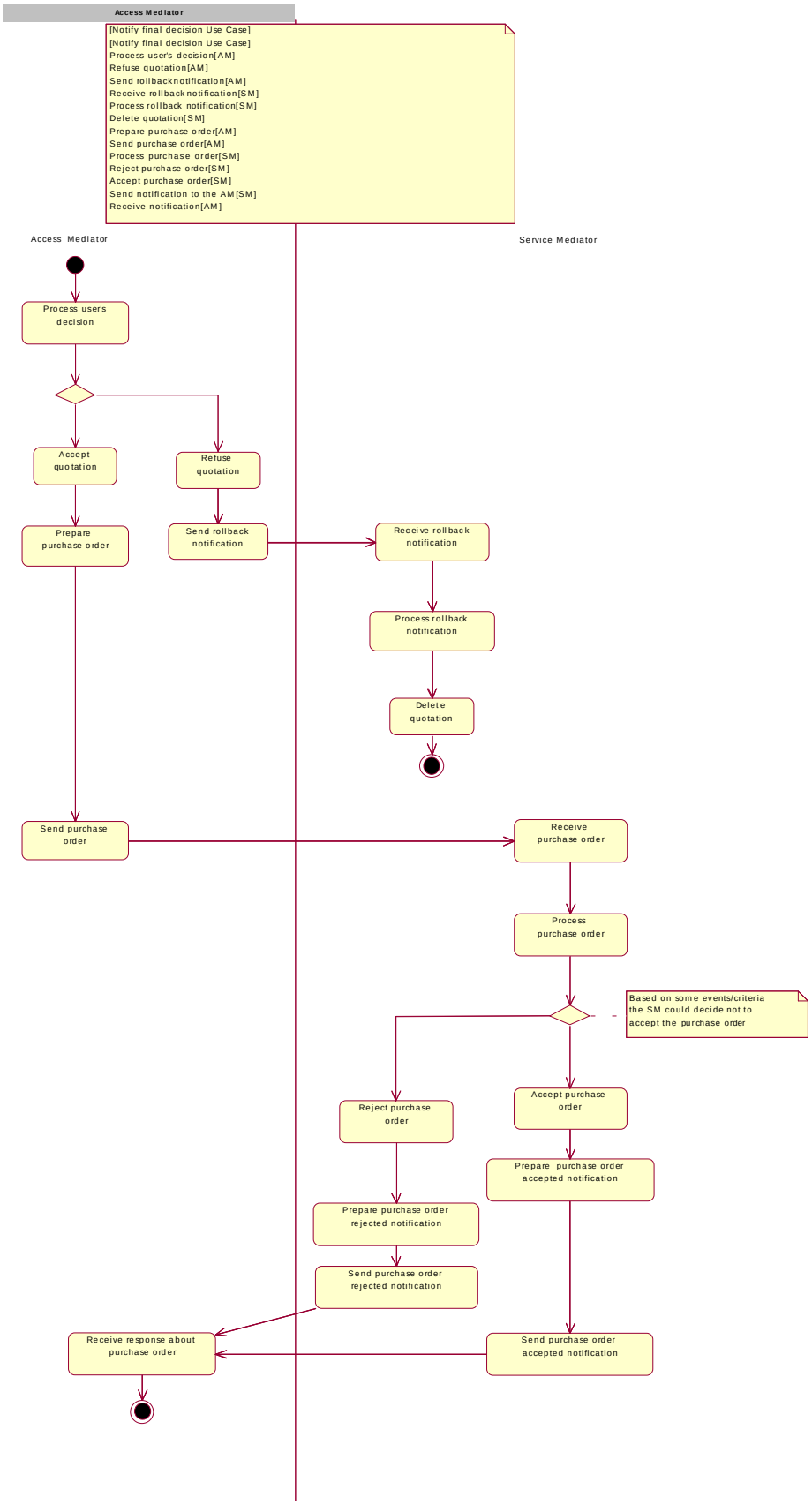

Figure 5: Activities performed in the Notify final decision use case.

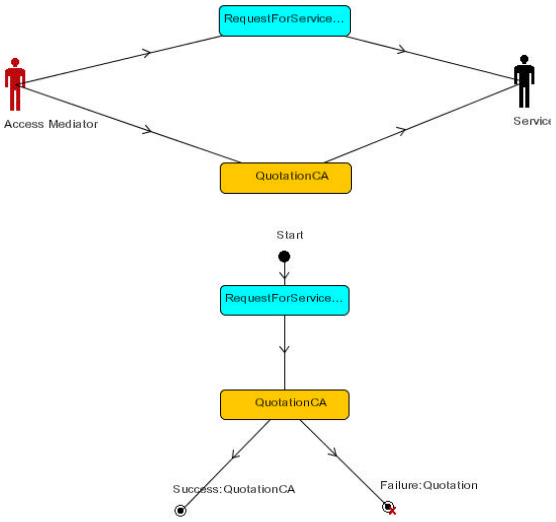

Figure 6: A high level view of the interactio tween AM and SM.

```
<RespondingRole name="Service Mediator"/>
<BusinessTransactionActivity businessTransaction="Quotatic
    fromAuthorizedRole="Access Mediator" isConcurrent="fal
    isLegallyBinding="true" name="QuotationBTA"
    toAuthorizedRole="Service Mediator"/>
<CollaborationActivity binaryCollaboration="OrderCO"
    fromAuthorizedRole="Access Mediator" name="OrderCA"
    toAuthorizedRole="Service Mediator"/>
<CollaborationActivity binaryCollaboration="CancelQuotationCO"
    fromAuthorizedRole="Access Mediator" name="CancelQuotationCA"
    toAuthorizedRole="Service Mediator"/>
<Start toBusinessState="QuotationBTA"/>
<Transition fromBusinessState="QuotationBTA" onInitiation="false"
    guardCondition="Commit" toBusinessState="OrderCA"/>
<Transition fromState="QuotationBTA" onInitiation="false"
    guardCondition="Rollback" toState="CancelQuotationCA"/>
<Success fromState="OrderCA" guardCondition="Commit"/>
<Success fromState="CancelQuotationCA" guardCondition="Rollba
<Failure fromState="OrderCA" guardCondition="Commit"/> <Failu
fromState="CancelQuotationCA" guardCondition="Rollback"/>
</BinaryCollaboration>
```

The *CancelQuotationCO* Collaboration (see Fig. 8) is n of a single business transaction activity (*CancelQuotation* during which a *rollback* message is sent from the AM to SM.

```
<BinaryCollaboration name="CancelQuotationCO">
<Documentation>    The "CancelQuotationCO" collaboration
    happens when the Access Mediator wants to send a rollback
    message to the Service Mediator
</Documentation>
<InitiatingRole name="Access Mediator"/>
<RespondingRole name="Service Mediator"/>
<BusinessTransactionActivity
    businessTransaction="CancelQuotationBT"
    fromAuthorizedRole="Access Mediator" isConcurrent="false"
    isLegallyBinding="false" name="CancelQuotationBTA"
    toAuthorizedRole="Service Mediator"/>
<Start toBusinessState="CancelQuotationBTA"/>
<Success fromBusinessState="CancelQuotationBTA"
    guardCondition="Success"/>
<Failure fromBusinessState="CancelQuotationBTA"
    guardCondition="Business Failure"/>
</BinaryCollaboration>
```

On the other hand, in order to send a *commit* message to the SM, the AM exploits the *OrderCO* Collaboration (see

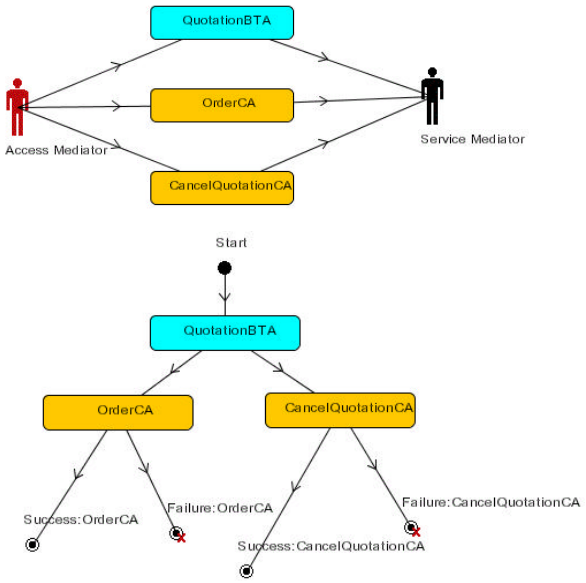

Figure 7: The Quotation Collaboration.

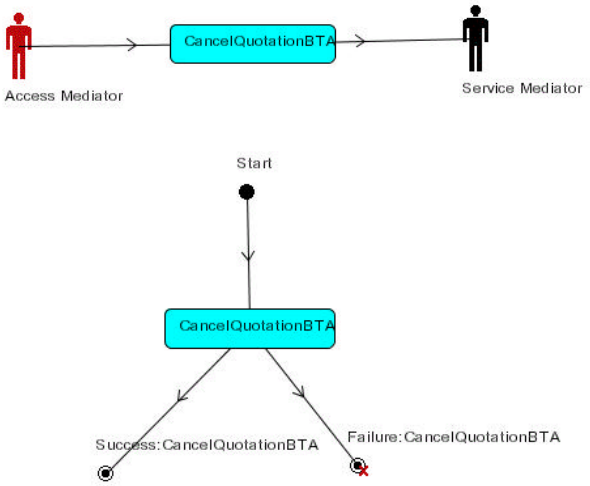

Figure 8: The Cancel Quotation Collaboration.

Fig. 9), which is also made of a single business transaction activity (*OrderBTA*).

```
<BinaryCollaboration name="OrderCO" timeToPerform="P2D">
<Documentation> The "OrderCO" collaboration starts with an
    OrderBTA business transaction activity, which indicates
    the AM will initiate it.  PurchaseOrderAcceptedDT from
    the OrderBTA activity will conclude the collaboration
    with a success. PurchaseOrderRejectedDT from the OrderBTA
    activity will conclude the collaboration with a failure.
</Documentation>
<Documentation>  timeToPerform = 2 days  </Documentation>
<InitiatingRole name="Access Mediator"/>
<RespondingRole name="Service Mediator"/>
<BusinessTransactionActivity businessTransaction="OrderBT"
    fromAuthorizedRole="Access Mediator" isConcurrent="false"
    isLegallyBinding="true" name="OrderBTA"
    toAuthorizedRole="Service Mediator"/>
<Start toBusinessState="OrderBTA"/>
<Success fromBusinessState="OrderBTA" guardCondition="Success"/>
<Failure fromState="OrderBTA" guardCondition="Business Failure"/>
</BinaryCollaboration>
```

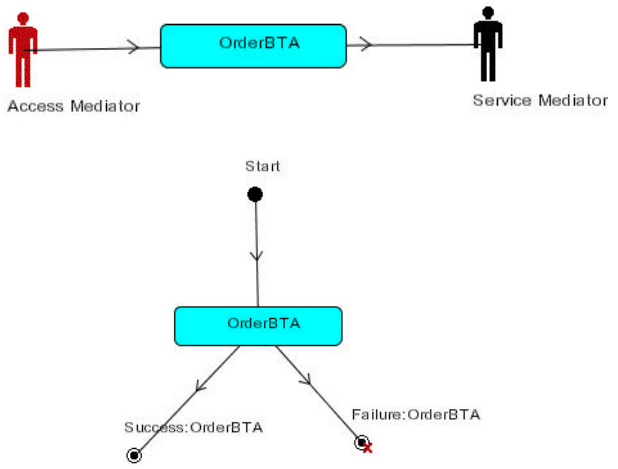

Figure 9: The Order Collaboration.

4.2.1 *The Mediators' Collaboration Protocol Profiles*

The business process modeling results in an ebXML Business Process Specification, which is referenced in the *Collaboration Protocol Profiles* (CPPs) of businesses. The CPPs, in turn, form the basis for *Collaboration Protocol Agreements* (CPAs) established between business parties. Ultimately, the business processes specified in the CPAs drive the service interfaces to execute those processes and send the required documents. As an example of such a process, we show in listing 4.1 the Collaboration Protocol Profile of the Access Mediator component.

As the reader will have noticed, the CPP defines the capabilities of a party to engage in electronic business with other parties. These capabilities refer both to technology features, such as supported communication and messaging protocols, and business features, in terms of what business collaborations are supported.

The CPP of the Service Mediator is quite similar and will be omitted for the sake of brevity.

4.2.2 *The Collaboration Protocol Agreement*

The CPA defines the way two parties will interact in performing the chosen business collaboration. Both parties use

Listing 4.1 CPP of the Access Mediator

```
<?xml version="1.0"?> <CollaborationProtocolProfile
    xmlns="http://www.ebxml.org/namespaces/tradePartner">
      <PartyInfo>
         <PartyId type="uriReference">
             urn:www.am.com
         </PartyId>
         <PartyRef href="" type="simple"/>
         <CollaborationRole id="CR1">
             <ProcessSpecification href="Cadenus"
                 name="NegotiateAndQuoteCO" type="simple" version="1.0"/>
             <Role href="Cadenus#AccessMediator" name="AccessMediator" type="simple"/>
             <ServiceBinding channelId="C1" packageId="P1">
                 <Service type="uriReference">
                     urn:www.am.com/services/NegotiateAndQuoteCO/AccessMediator
                 </Service>
             </ServiceBinding>
         </CollaborationRole>
         <Certificate certId="CRT1">
                 <KeyInfo/>
         </Certificate>
         <DeliveryChannel channelId="C1" docExchangeId="DE1" transportId="T0">
             <Characteristics authenticated="false" authorized="false"
                 confidentiality="false" nonrepudiationOfOrigin="false"
                 nonrepudiationOfReceipt="false"
                 secureTransport="false" syncReplyMode="none"/>
         </DeliveryChannel>
         <Transport transportId="T0">
             <SendingProtocol version="1.0">HTTP</SendingProtocol>
             <ReceivingProtocol version="1.0">HTTP</ReceivingProtocol>
             <Endpoint type="allPurpose"
                 uri="http://217.9.64.244:9070/testAM/servlet/BindMessageRouter"/>
         </Transport>
         <DocExchange docExchangeId="DE1">
             <ebXMLBinding version="1.0">
                 <ReliableMessaging deliverySemantics="BestEffort"
                     idempotency="false"
                     messageOrderSemantics="NotGuaranteed">
                         <Retries>0</Retries>
                         <RetryInterval>0</RetryInterval>
                         <PersistDuration>P</PersistDuration>
                 </ReliableMessaging>
             </ebXMLBinding>
         </DocExchange>
      </PartyInfo>
      <Packaging id="P1">
         <ProcessingCapabilities generate="true" parse="true"/>
         <SimplePart id="SP0" mimetype="text/xml"/>
      </Packaging>
      <Comment>Access Mediator profile</Comment>
```

identical copies of the CPA to configure their run-time systems. This assures that they are compatibly configured to exchange messages, independently of the particular run-time systems they exploit. Usually, a CPA is composed by intersecting the respective CPPs of the parties involved: it will thus contain only those elements that are in common, or compatible, between the two parties.

5. CONCLUSIONS AND FUTURE WORK

In this paper we presented a novel approach to the design of an architecture for the effective deployment of value-added Internet services upon Premium IP networks. We proposed a model based on a modular decomposition of tasks involved in the deployment process, exploiting at its best the concept of "mediation". Finally, to give an idea of how this concepts apply in a real-world operational scenario, we focused on an actual example related to the design of the interaction between the mediation entities in the electronic market-place. This definitely represents the research field we are mostly interested in further investigating, due to the challenging topics it proposes.

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