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Collaboration Based on Web Services

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INTRODUCTION

Web services are software components designed to support interoperable machine-to-machine interactions over a network, through the exchange of SOAP messages. Since the underlying technology is independent of any specific programming language, Web services can be effectively used to interconnect business processes across different organizations. However, a standard way of representing such interconnections has not yet emerged and is the subject of an ongoing debate.

In this area, the term *collaboration* has often been used to denote a situation in which two or more business processes (participants) cooperate by means of Web services, so as to achieve a common goal. In particular, when only two participants are involved, the more specific term *binary collaboration* is preferred, while when there are three or more, the term *multi-party collaboration* can be used instead. The notion of binary collaboration is fundamental, as any multi-party collaboration ultimately relies on a number of binary collaborations.

Collaborations can be described by collaboration models, which provide a control-flow view of the intended global behaviour. These models are addressed from two perspectives, one focusing on the observable activities of the participants, and the other on their *interactions*.

The first approach defines the observable activities of the participants as well as their ordering constraints by means of a global model called inter-organizational workflow. As an example, the public-to-private approach (van der Aalst & Weske, 2001) is a top-down technique based on three steps: at first the participants agree on a global model represented by a Petri net, then the public model is partitioned into public parts, one per participant, and finally each participant refines its public part into a private workflow. The refinement process guarantees that the private workflows conform to the global model.

The approach focusing on interactions is more abstract. In fact, interactions are carried out by message-sending activities and message-receiving ones. There are two types of interactions: one-way interactions and two-way ones; a two-way interaction consists of two one-way interactions in the opposite directions. As a matter of fact, a one-way interaction subsumes two activities, a message-sending activity in one business process, and a message-receiving activity in another.

This article follows the interaction-oriented approach and illustrates binary collaborations and multi-party ones with the help of an informal notation called "interaction diagrams."

MODELS OF BINARY COLLABORATIONS

Well known models of binary collaborations are the partner interface processes (PIPs) developed by the RosettaNet consortium (Damodaran, 2004). A PIP refers to two roles, consists of a one-way or two-way interaction, and specifies the business documents to be exchanged as well as the quality of service (QoS) requirements (such as timeToPerform, timeToAcknowledgeReceipt and retryCount).

As an example, PIP 3A1, "request quote," shown in Figure 1, enables a buyer to request a product quote from a provider, and a provider to respond accordingly. The model is based on the modeling methodology promoted by UN/CEFACT ("UMM," 2003) and referred to as UMM. The two participants are represented by a pair of business activities: getQuote is the requesting activity and provideQuote is the responding one. RequestForQuote and quote are called action messages. Action messages are acknowledged by positive or negative signal messages, not shown in Figure 1; usually a signal message acknowledges that an action message has been received and has been syntactically validated. The business activities are involved in four

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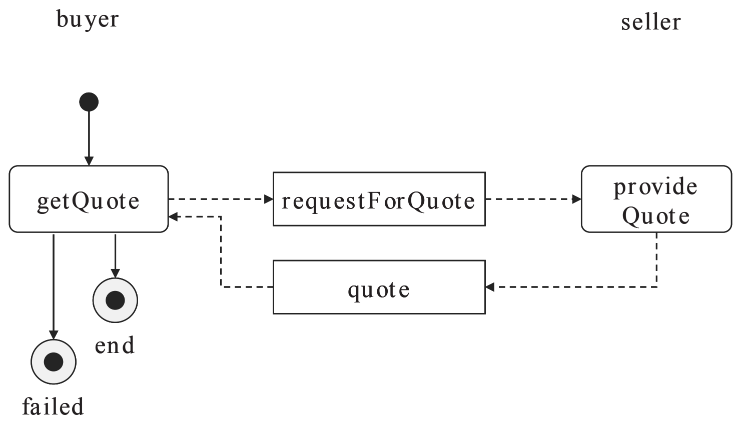
Figure 1. The UML model of PIP 3A1 (request quote)



message exchanges, concerning two action messages and two signal messages.

The model in Figure 1 conveys the transactional nature of the interaction: the requesting activity ends in two alternative states, "end" and "failed." The success state (end) indicates that all the messages have been properly received. The failure state takes into account all the possible exceptions, which can be divided into communication exceptions, business exceptions (when a message is not understood) and timeout ones.

The business transaction activities defined in UMM are similar to RosettaNet PIPs. UMM allows business transaction activities to be combined into choreographies, which are called "business collaboration protocols." They are modelled as universal modeling language (UML) ("UML," 2005) activity diagrams and can include four control-flow elements: decision, merge, fork, and join. An equivalent XML representation can be obtained by means of the business process specification schema (BPSS), which is part of the ebXML framework ("BPSS," 2001).

The current version of BPSS supports binary collaborations only, while UMM addresses choreographies. In fact, UMM does not address binary collaborations specifically as the business transaction activities contained in the same business collaboration protocol may be performed by different pairs of business partners (Hofreiter, Huemer, & Kim, 2004). BPSS, unlike UMM, allows business collaborations to be nested.

The notation informally presented in this article (i.e., interaction diagrams) draws on UMM with two major differences.

The UMM notation is affected by redundancy. In fact, the business activities appearing in a UMM business transaction activity (which is similar to a RosettaNet PIP such as the one shown in Figure 1) do not play any functional role; they only serve as a support for QoS parameters. Therefore, the major building blocks in interaction diagrams are the interactions, which do not need to be further decomposed but can directly be associated with QoS parameters. Collaboration "RfQ" shown in Figure 2a is the equivalent of PIP 3A1 presented in Figure 1. It is a simple binary collaboration consisting of a single two-way interaction.

In an interaction diagram, the two participants involved in the binary collaboration are denoted by their roles such as *buyer* and *supplier*; roles appear in brackets after the collaboration name. The first role designates the collaboration *initiator* (or *requester*), and the second one designates the collaboration *provider*.

Interactions are depicted as rectangles containing the names of the messages involved and can be labelled with identifiers, such as *i1*. In two-way interactions, a slash (/) separates the request message from the response one. The types of the messages are defined in an XML schema file associated with the collaboration model.

An interaction takes place between two participants, denoted by two conventional roles, for example, *initiator* (or requester) and *responder* (or *provider*). The collaboration requester coincides with the initiator of the first interaction. If an interaction is initiated by the collaboration provider, the request message is underlined (this case does not appear in Figure 2).

The second difference between interaction diagrams and UMM lies in the way of expressing conditions in control-flow elements: a condition in UMM is mainly related to the availability of a business object in a given state. However, collaborations should not depend on external entities, such as the business objects postulated in UMM conditions, as different interpretations can be

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