TOWARDS A META-MODEL FOR WEB SERVICES' PREFERENCES

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Keywords: Membership, Policy, Preference, Privacy, Web service.

Abstract: This paper presents a meta-model for describing preferences of Web services. Two types of preferences are examined namely privacy and membership. Privacy restricts the data that Web services exchange, and membership restricts the peers that Web services interact with. Both types have risen lately with force in response to the open and dynamic nature of the Internet. While most of the research work on Web services has been driven by the concerns of users, this paper stresses out the concerns of providers of Web services. Different meta-classes like Web service, functionality, and WSDL are included the meta-model for Web services' preferences. To guarantee the satisfaction of these preferences, policies are developed in this paper.

1 INTRODUCTION

Over the last few years, the research community examined Web services from different perspectives such as composition, semantic mediation, and context-awareness. Recently, a new perspective that emphasizes *privacy* concerns has risen with force in response to the open and dynamic nature of the Internet. Web services are expected to handle users' personal details in compliance with existing privacy standards (WSP, 2009; W3C, 2003) and public legislations (Commission, 2008). Some countries like Canada have even set up a dedicated body to implement and enforce these legislations.

It is worth mentioning that the majority of Web services R&D projects are user-centric; the priority is always given to users' concerns: how to look for Web services to satisfy a user's needs, how to personalize a Web service with respect to a user's profile, how to protect a user from malicious Web services, how to ease the discovery of Web services as per a user's needs, etc. Although it is critical to guarantee user satisfaction towards Web services use, a few R&D projects look at the other side of the spectrum, which emphasizes providers' concerns. Providers are put on the first line of satisfying Web services' promises (i.e., loosely-coupled application development) on top of their regular duties of developing and maintaining Web services. In the literature, it is always guaranteed that Web services always accept to engage in composition scenarios, process users' requests, and interact with other peers. This should not always be the case as Web services (in accordance with their providers' policies) could reject processing users' requests due to current high-load or non-appealing rewards, propose peers with whom they would like to partner during composition, review their internal use policies without prior notice, and initiate some sort of negotiation with other peers in order to satisfy the most of their preferences. In (Maamar et al., 2004), we discuss how Web services performance can be restricted because of lack of computing resources upon which these Web services will run. In this paper, we show how providers set preferences that would let their Web services postpone or cancel their participations in compositions if their preferences are not satisfied, as well as relax these preferences if needed. *TypeOfPeer* and *DataQuality* are examples of preferences associated with Web services, but additional examples are provided later.

To ease the exercise of modeling preferences of Web services, we develop in this paper a meta-model that structures the types of preferences, the relationships (e.g., cause-effects, complementary, etc.) that could exist between these preferences, the restrictions that could be put on these preferences, and finally the mechanisms that would support (automatically if possible) the mapping of these preferences onto ex-

Maamar Z., Al-Khatib G., Elnaffar S. and Baghdadi Y. (2010).
TOWARDS A META-MODEL FOR WEB SERVICES' PREFERENCES.
In *Proceedings of the 5th International Conference on Software and Data Technologies*, pages 113-118
DOI: 10.5220/0002888901130118

ecutable policies. Such policies will be triggered to guarantee that Web services' preferences are satisfied at run-time. The rest of this paper is organized as follows. Section 2 presents some related work. Section 3 discusses the preferences of Web services. Section 4 introduces the meta-model of these preferences. Finally, Section 5 concludes the paper.

2 BRIEF LITERATURE REVIEW

In (Benbernou et al., 2007b), Benbernou et al. propose a privacy-agreement model for Web services. They point out that despite the increasing number of privacy policies that businesses advertise, Internet users are not convinced yet with the way their personal details are handled and how compliant these businesses are with these policies. As a result, users continue to be reluctant to disclose such details. The privacy-agreement model of Benbernou et al. consists of rights and obligations that can be used to accommodate new business strategies and changes in personal data-related laws and regulations.

In (Xu et al., 2006), Xu et al. mention that privacy concerns should be handled during the development phase of a composite Web service. The number of people who access the Web continues to grow, which has exacerbated these concerns. To address this exacerbation and the Platform for Privacy Preferences' (P3P) shortcomings, Xu et al. propose a framework for the development of privacy-conscious composite Web services. When a user provides data to a Web service, she needs guarantees that these data will be manipulated in accordance with her privacy preferences. The user can request to check the model of a Web service so that she can know how this Web service processes and shares data. In the framework of Xu et al., automated techniques check the compliance of a Web service's model with a user's privacy preferences.

In (Park et al., 2005), Park et al. incorporate preferences into Web services conversations in order to accommodate users who are on the move and thus, dependent on wireless network availability and reliability. Park et al.'s framework called WS-CPP for Web Services Conversations Preference Profile defines documents that include a specific element known as preference. This specific element governs the interaction behavior of both service provider and client. A preference may contain zero or more of the following entities: interactionSkip, choicePriority, and orderPriority.

In (Carminati, B. and Ferrari, E. and Hung, P.C. K., 2005), Carminati et al. discuss privacy in the context of agencies dedicated to Web services discovery. These agencies (e.g., built upon UDDI registries) need to have access to some Web services' sensitive information for various reasons like identifying appropriate Web services with respect to users' needs. However, some providers of Web services could be reluctant to give discovery agencies free access to these sensitive information.

3 PREFERENCE DEFINITION

Prior to discussing how a Web service controls its participations in composition scenarios through preferences, we show first, how to include preferences in the description of the Web service. To this end, we decompose this description into two parts: functionality and preference. The functionality part consists of the "service" that the Web service offers to users and peers for invocation. The preference part consists of concrete types of preferences that the Web service makes sure of their satisfaction at run-time. Each preference type is related to a category, which we denote by either *privacy* or *membership*.

3.1 Running Example

Our running example is a university student who would like to organize a cookout party for his recent graduation. We identify some potential Web services that could be in charge of the logistics of this party.

CateringWS: looks for and contacts catering companies according to some criteria like allocated budget, number of expected guests, and type of cuisine.

GuestWS: sends invitees invitations, keeps track of confirmed invitations, and follows-up on unconfirmed invitations through reminders.

PlaceBookingWS: looks for a place to host the cookout party, books the place, and completes the necessary paperwork like payment.

WeatherWS: checks weather forecast for the day of the cookout party. In case of bad weather, the party takes place at the student's place.

3.2 Privacy-based Preferences

In Wikipedia, privacy is "*... the ability of an individual or group to seclude themselves or information about themselves and thereby reveal themselves selectively. The boundaries and content of what is considered private differ among cultures and individuals, but share basic common themes...*" (en.wikipedia.org/wiki/Privacy). Privacy are related to different themes such as data, financial, Internet, and political.

Research on privacy through the P3P and Enterprise Privacy Authorization Language (EPAL) initiatives is still confined to user-Web site interactions (Benbernou et al., 2007a). A user needs to know among other things why she submitted her credit card number to a Web site, how long this Web site will retain this number, and how she could verify that this number was effectively deleted as the Web site claims. In the following, we briefly go over P3P and EPAL.

P3P: In (Hua Li et al., 2006), Hua Li et al. provide a concise summary of P3P, which we adopt in this paper. XML-based P3P is the most significant effort that gives Internet users the opportunity to gain control over their personal details. A privacy policy in P3P is a set of statements. Each statement has four different components: data group, purpose, recipient, and retention.

EPAL: It "*... is a formal language for writing enterprise privacy policies to govern data handling practices in IT systems according to fine-grained positive and negative authorization rights*" (EPAL's Web site). An EPAL policy defines (i) lists of hierarchies of data-categories, user-categories, and purposes, and (ii) sets of (privacy) actions, obligations, and conditions.

The above initiatives/standards are user-centric; the data collected concern users, only. In the following, we discuss privacy-based preferences from the perspective of a provider that would like to have control over the data that its Web service manipulates. These data are part of the business logic that underpins the functioning of the Web service. First of all, we identify some privacy-based preference types that apply to Web services and then, show if any correspondence exists between these types and P3P or EPAL components.

1. *DataSource*: a Web service specifies a list of direct peers (i.e., other Web services) from which it accepts input data without for example checking their credentials (Li et al., 2007).

2. *DataDestination*: a Web service specifies a list of direct peers for which it forwards output data without for example checking their credentials (Li et al., 2007).

3. *DataRetentionPeriodAtDestination*: a Web service sets an appropriate duration for direct destination peers to retain its output data whether these data are updated or not at the destination level. When this duration elapses, the data should be either deleted or forwarded as long as the privacy-based preferences of the sender and destination peers are satisfied. It is expected that the recipient Web services to a Web service announce their respective *DataRetentionPeriodAtReception* preferences as a counter-part of the *DataRetentionPeriodAtDestination* preference of this Web service.

4. *DataDisclosureDistance*: a Web service sets the maximum distance for its data to be disclosed (or forwarded) from one peer to another without seeking its direct approval. For example, distance *2* would mean the peers that are directly connected to a Web service and the next direct peers that are connected to these peers. In any case, the peers have to take into account their own *DataSource*/*DataDestination* preferences prior to receiving/forwarding data. It is expected that the recipient Web services to a Web service announce their respective *DataDisclosureDistance* preferences in response to the *DataDisclosureDistance* preference of this Web service.

Table 1 suggests correspondences between our proposed types of privacy-based preferences and P3P and EPAL components. In the list of privacy types (column #2), *DataDestination* and *DataRetentionPeriodAtDestination* preferences have direct counterpart components in P3P and EPAL. The rest of preferences do not have because of their specific role in composition scenarios. *DataSource* focusses on the previous component Web services, and *DataDisclosureDistance* focusses on the next component Web services. It would be appropriate to add these two privacy-based preference types to P3P and EPAL for the following reasons:

1. A Web site could submit a user's details to other Web sites without the knowledge/approval of the user; this could be prevented through *DataDisclosureDistance*;

2. And, a Web site could use details from other Web sites to satisfy a user's request without the knowledge/approval of the user; this could be prevented through *DataSource*.

Example. We instantiate the proposed privacy-based preference types using *PlaceBookingWS*.

- *DataSource*: null.
- *DataDestination*: *GuestWS*.
- *DataRetentionPeriodAtDestination*: up to *1* month from date of receipt.
- *DataDisclosureDistance*: *2* – *CateringWS* could receive data of *PlaceBookingWS* from *GuestWS* without the approval of *PlaceBookingWS*.

Table 1: Privacy preference correspondences.

#	Proposed privacy type	P3P component	EPAL component
1	*DataSource*	null	null
2	*DataDestination*	Recipient	User categories
3	*DataRetentionPeriodAtDestination*	Retention	Obligations
4	*DataDisclosureDistance*	null	null

3.3 Membership-based Preferences

Membership-based preferences reinforce the capacity of a Web service to control its participations in composition scenarios. By accepting to engage in these scenarios, a Web service puts some restrictions on its engagement by using preferences. Similarly with privacy-based preferences, we identify some membership-based preference types that apply to Web services and then, show if any correspondence exists between these types and P3P or EPAL components.

1. *ParticipationDuration*: because Web services can engage in long-running composition scenarios that sometimes last days and even weeks (Little, 2003), a Web service could set the maximum duration it would remain committed to a certain scenario whether the performance of this Web service is finished or not. *ParticipationDuration* gives a Web service the possibility to automatically disengage from composition scenarios that last more than expected and engage in other compositions if such opportunities arise. It would also allow a Web service to stipulate another pricing model, if it decides to relax this membership preference.
2. *InvocationPeriod*: to maintain a certain level of QoS (Sun et al., 2007), a Web service could set different time periods (e.g., off peak, peak) to receive and process execution requests. These periods could be driven by factors like service level agreements, business hours, computing resource availabilities, etc.
3. *PaymentMode*: in return to processing users' requests, a Web service could be financially compensated either instantly after satisfying these requests or deferred until the successful completion of the composition scenario in which this Web service takes part now. In case of composition-scenario failure, a Web service could request cancelation fees on top of the regular fees that it charges[1]. However, if a Web service is faulty, then it will bear financial penalties (when applicable).
4. *BlackListedPeers*: it is a list of Web services that a Web service does not wish to deal with them directly, or even if they exist as part of a composition scenario. For example, a Web service does not wish to deal with those Web services that may degrade its QoS or threaten its privacy or security measures.
5. *FavoredPeers*: this allows a Web service to selectively choose to favor the participation in one composition over the other due to the existence of good peers. This preference may stem from the positive experience with those favored Web services.

Table 2 suggests correspondences between our membership-based preference types and P3P and EPAL components. In the list of membership types (column #2), *ParticipationDuration*, *FavoredPeers*, and *BlackListedPeers* have "Retention", "Recipient", and "Recipient" P3P parameters as counterparts. From a user perspective, "Retention" component could mean the maximum time-period that a user would be willing to spend interacting with a Web site. If a user has to complete a 15 minute survey while her next meeting is in less than 10 minutes, the Web site could be informed about the user's availability so that appropriate actions are taken. "Recipient" component could mean both the Web sites that a user would like to visit and not to visit. In EPAL, "Obligations" component could be associated with *ParticipationDuration* and "User categories" component could be associated with *FavoredPeers* and *BlackListedPeers*. From a user perspective, "Obligations" component could refer to the actions to take when the user decides to disengage from an interactive session without prior notice. And, "User categories" component could refer both to the Web sites that a user would like to visit and not to visit. Finally, it would appropriate to add *InvocationPeriod* to both P3P and EPAL for a better access management to Web sites.

Example. We instantiate the proposed membership-based preference types using *CateringWS*.

- *ParticipationDuration*: *48* hours – if the execution of the cookout-party composition lasts more than forty eight hours, *CateringWS* will automatically disengage itself from this composition. A remedy to this "expected" disengagement needs

[1] Cancelation fees are applicable when a Web service that has completed its execution, needs now to cancel or compensate this execution.

Table 2: Membership correspondence arguments.

#	Proposed membership type	P3P component	EPAL component
1	*ParticipationDuration*	Retention	Obligations
2	*InvocationPeriod*	null	null
3	*PaymentMode*	null	null
4	*BlackListedPeers*	Recipient	null
5	*FavoredPeers*	Recipient	User categories

to be planned by the composition designer for instance negotiating a longer engagement period with *CateringWS*.

- *InvocationPeriod*: null.
- *PaymentMode*: deferred – *CateringWS* expects payment after the whole composition is completed with success. In case of failure that requires cancelation, *CateringWS* will charge additional fees.
- *BlackListedPeers*: null.
- *FavoredPeers*: *PlaceBookingWS* – *CateringWS* has an excellent experience dealing with *PlaceBookingWS*.

4 META-MODELING

We propose a meta-model to describe Web services' preferences and then show how this meta-model is used to generate policies that guarantee these preferences satisfaction at run-time.

4.1 Proposed Meta-model

As Jegadeesan and Balasubramaniam report in (Jegadeesan and Balasubramaniam, 2009), the goal of a meta-model is to have a minimum number of elements with maximum expressivity, and reduce the representational gap for domain experts to use it. Our meta-model for Web services' preferences is represented in Figure 1 and consists of the following metaclasses: *Web Service*, *Functionality*, *WSDL*, *Preference*, *Privacy*, *Membership*, *Value*, *Single* (Value), and *Multi* (Value).

- A Web service is associated with a WSDL document that is used among other things to identify the functionality and preferences of the Web service.
- A preference is identified with a name of type String and a priority level of type Integer. This priority level is a non-negative integer that shows how strictly a preference should be satisfied. Zero priority is the most restrictive level, which means that satisfying this preference is mandatory. High levels suggest that the preference is optional yet prioritized according to its level; the higher the level is the less important it is).
- A preference is specialized into privacy and membership types.
- A preference's value could be either single (e.g., *DataRetentionPeriodAtDestination* of type Integer) or multiple (e.g., *FavoredPeers* of type List of Peers). This is represented through the value class.
- All peers that a Web service interact with are of type Web service.

4.2 Policy Definition

Following the definition of a meta-model of preferences for Web services in Figure 1, we move now to the generation of policies that guarantee the satisfaction of these preferences at run time. We start by developing an XML schema of this meta-model. Afterwards, we instantiate this XML schema to illustrate some concrete Web services' preferences. This also allows generating policies, which can be done using XQuery or XPath. Examples of queries that could be run over the XML model include: Query_1: List the priority for the payment mode preference for a given WS, Query_2: List the names of preferences who has a positive priority, and Query_3: List the peers for the data source preference

5 SUMMARY

We presented our work on meta-modeling the preferences of Web services. The objective is to identify which preferences could be associated with Web services and how to structure these preferences in terms of type, relationship, and restrictions. Two types of preferences have been examined namely privacy and membership. On the one hand, privacy restricts the exchange of data between Web services. This happens using different arguments such as *DataSource*, *DataDestination*, *DataRetentionPeriodAtDestination*, and *DataDisclosureDistance*. On the other hand, membership restricts the interactions between Web services. This happens using different

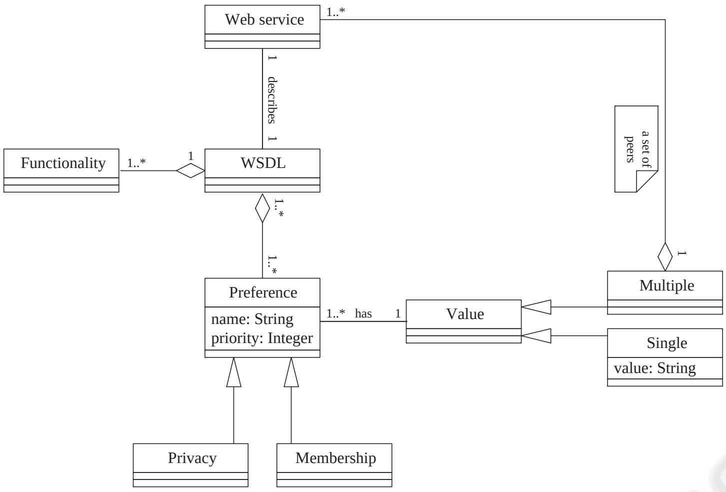

Figure 1: Meta-model for Web services' preferences.

arguments such as *BlackListedPeers*, *PaymentMode*, *InvocationPeriod*, and *ParticipationDuration*.

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