Formal Description of Services Interfaces of SMAL Services in Services Computing Environment

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***Abstract*—In this paper, we describe U-S and S-S variants of interactions for services defined for SMAL organization which are described using the web services ontologies. We identify that just by defining ontologies for U-S interfaces will not suffice for the system, rather we require a state-of-the-art ontologies for S-S interfaces too. The services ontologies are defined using WSML which is a standard defined by Web Services Modeling Ontologies (WSMO). The policy-based access control framework requirement of the system presented can be accomplished by deploying either XACML or SAML, or some other rule-based implementation of access control framework which has been defined as the future scope of our work.Further, by describing and identifying the problem, we move onto the later phases, i.e., formal specification, verification, and development for evaluating the system on defined parameters.**

***Index Terms*—Semantic computing, semantic web services, WSML, WSMO.**

I. Introduction

Recent advances in Web have led to the definition of Web 3.0 which includes; semantic web, personalization, intelligent search, behavioral advertising campaign, REST etc. Semantic web talks of defining and describing web and ontologies are one of the ways to describe or classify the Web. For example, Web Ontology Language, Web Services Modeling Language, DARPA Agent Markup Language are examples of few mark-up languages used to describe the ontologies of a web-services system. Resource Definition Framework (RDF) is one of the metadata models to describe semantics of web services. It is a serialization format given in RFC 3870 [1], which defines it as a language to support Semantic Web, by facilitating resource description and data exchange on the web. Further, a web services system can be categorized and described using the taxonomy of the services computing environment. A web-services system lies in the bounds of services which can be described in terms of input, output, objectives of system, and the control and monitoring elements of the system [2, 3]. Also, The web-service includes, three major parties; service requestors or services consumers, service provider or services distributor, and service registry or services hosts [4].

We've identified two types of communications between asynchronously communicating web-services; user-services communication (U-S) and service-service (S-S) communication. In this paper, we intend to describe a web-services system using ontologies and also identify two kinds of communications between the services, viz., user-service communication (U-S) interface; and service-service communication (S-S) interface. The U-S interface is obvious and is mostly observed when any user communicates or instructs a web-service. The command instructed by the user is generally given as set of parameters to the web-service from the front-end interface of the web-service. However, in case of an S-S interface, a web-service invokes another web-service with the same parameters or a subset of parameters; which can be observed as a case of delegation. We focus on both the kinds of communications and describing ontologies for both U-S and S-S communications. Specifying a U-S communication is obvious, but, specifying ontology for S-S kind-of communication would make the service intelligent enough to understand policies.

In this paper, we intend to achieve an ontology description and formal methodology for the specification of web-services system which will later be used for other phases of state-of-the-art access control implementation for defining the system. Section II describes the problem, which is the service interaction of the SMAL organization. The services interactions of SMAL organization evolve in the Section II of the paper only. Section III discusses the ontology modeling for developing ontologies of the system proposed. Along with modeling ontologies, we also model the services and services interactions required at the SMAL-end to identify various U-S and S-S interactions in the system. And finally, Section IV presents the conclusions and future work.

II. Motivation and Problem Description

We consider an example of an organization SMA Limited, which is a digital gadget manufacturer company manufacturing audio/video player, named avPad which along with playing both audio and video media can also download media from Internet. The avPad is also available for purchase online using transactions over Internet.

Also, we consider that SMAL has tied up with various other third-party service providers offering audio and video downloads (say AVS) to the customers of avPad, by charging SMAL of their services being used accordingly. AVS, in turn, provides the service which includes listing of media-items, small preview of media-item before the user decides to download, download of the media-item, and finally, debit charges for the downloaded media-item. The media-items are classified and sorted by their genre, year, publisher, artist, etc. Additionally, SMAL uses services of some cheap and best

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postal service FPS which offers pick-up from the SMAL offices and assures a delivery time to the customers of SMAL. Also, SMAL uses some cheap and best credit card gateway processing services provided by OCCP wherein all the major cards are accepted except for wire-transfers and bank-transfers.

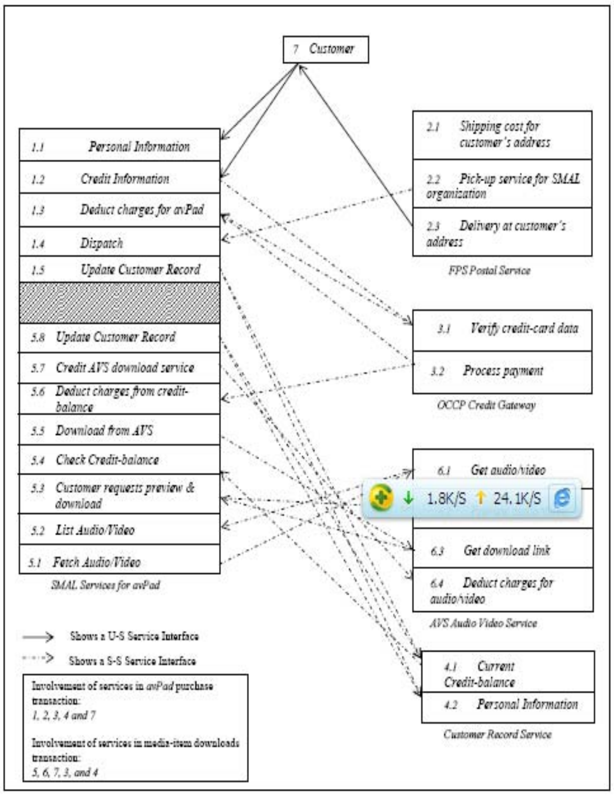

Fig. 1. Scenario of various services interactions at SMAL organization for AVPAD product.

When the customer comes for the first time to buy the avPad, the SMAL services gets the personal information for FPS. SMAL services also ask the customer for the credit balance that is to be kept with the organization for media-item download service. After getting the credit information and all other required information, the customer is transferred to OCCP for validating the credit card information. If the credit transfer was successful, the FPS is informed and the customer database is updated. The FPS picks-up the gadget and delivers it to the customer's provided address. The credit balance is updated in the customer's records for the organization's own use.

The avPad manufactured by SMAL organization uses wireless/3G technology to connect to Internet and log-on to the portal where the user is given access based on some defined mechanism and then allowed to download, if he has already purchased the balanced to do so or produced the credit card for downloading audio/video. Based on the access given, the audio/video list is fetched from the partner service providers and offered to the user. The user can then select from any audio/video from the given list, preview it using the streaming service, and finally download it. When the user has downloaded it, the credit for the download will automatically be debited from the user's account using the OCCP's services and then the appropriate credit will be given to AVS's service by SMAL's download service. The access rules are required so that the credit balance is allowed to be used for the customer who has logged-in. Here, we need access rules for the services. One can easily talk to AVS service sending the input token of SMAL service having login-information of some customer, commonly known as *metadata spoofing*.

Fig. 1 above shows communication interfaces of U-S and S-S types. It can be easily identified from the above scenario whether the given interaction is of U-S type or S-S type. Now, SMAL also provides a sync application avSync with which a user can easily sync all the data from avPad to the user's PC/laptop/mobile. Also, the download service can be extended by providing a token to user and allowing the user to login from any device, be it a PC/laptop/mobile/avPad and downloading the audio/video (collectively named media-item henceforth) based on user's selection preferences. This scenario leads to a complex system wherein any device connects to SMAL services and requests for download. The scenario is as shown in Fig. 2 below.

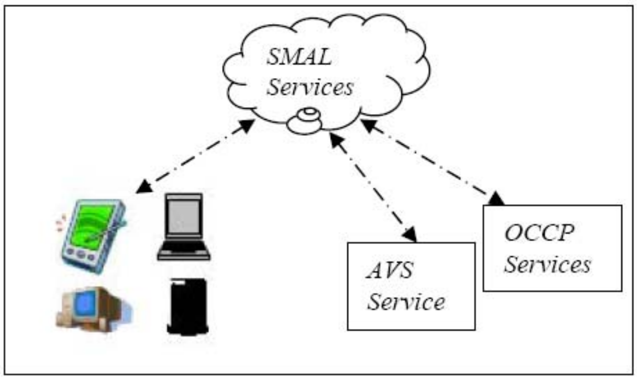

Fig. 2. Scenario for device interactions with SMAL services.

The U-S interfaces need authentication, authorization and auditing in place, and hence a necessity for an access control framework arises for such a system. The access control will help resolve various U-S authentication issues, U-S authorization issues and also provide auditing for all the transactions that occur between the user and the SMAL services. The need for this kind of access control will be fulfilled using some kind of SAML, XACML, or some rule-based access control system as discussed later. The access control to be deployed should be flexible enough that if SMAL organization ties up with some other media-item services after some given period of contract with a media service provider, AVS in this case; then it should not have problem with switch-over, i.e., the transition to the new services provider should be smooth.

To consider such a situation, let's consider that SMAL organization in our example has also tied up with one audio services provider ASP, and video services provider, VSP for getting the results of various audio and/or video and providing services to its consumers. The consumers, in turn, now can select from thousands of selection of audio and video media-items and download them based on their current credit-balance. Also, at a later stage, the SMAL organization can start to opt to accept bank transfers and wire-transfers. To accept bank and wire transfers, SMAL organization now uses services of BTS along with OCCP gateway. So, the visualization of the services interactions of various services providers with SMAL organization is as shown in Fig. 3.

Fig. 3 shows various S-S interfaces and includes services from providers as discussed above. Next, we model the services in modeling toolkit and various ontologies in the modeling environment.

III. Ontology Modeling

We model the problem described above using WSML-Rule. WSML is available in five flavors; WSML-Core, WSML-DL, WSML-Flight, WSML-Rule, and WSML-Full [5]. We select WSML-Rule as our choice for presenting the problem. We use Web Services Modeling Toolkit 2.0 [6], [7], for modeling the given problem using WSML-Rule and selecting the Heavyweight-Rule for the capability description. The toolkit helps in visualizing the modeled web services along with writing the WSML-rule code for the web-services, and ontologies.

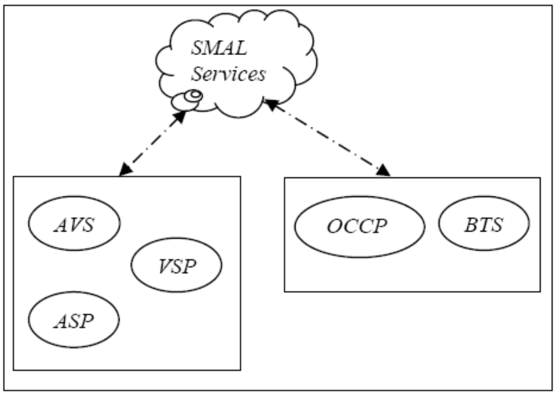

Fig. 3. Scenario for services interactions between various services providers and SMAL services.

```
wsmlVariant
_"http://www.wsmo.org/wsml/wsml-syntax/ws
ml-rule"
namespace
{ _"http://smal.org/avpad/services#",
discovery
_"http://wiki.wsmx.org/index.php?title=Di
scoveryOntology#" }
webService AvPadPurchase
capability AvPadPurchaseCapability
 nonFunctionalProperties
    discovery#discoveryStrategy hasValue
discovery#HeavyweightDiscovery
 endNonFunctionalProperties
precondition StoreCustomerDetails
postcondition ShippingAvPad
  definedBy
 customer subConceptOf CustomerDetails
  and hasValueIn(customer, address)
  and paymentCompleted(customer).
postcondition DebitAvPadExpenses
     definedBy
deductChargesFromCrediCard(CreditCardValu
e,((MinimumCreditBalance+AvPadPurchaseVal
ue)+ShippingCost)).
interface CustomerDetails
```

Fig. 4. WSML for AVPAD purchase service

Fig. 4 shows a sample of WSML output of the avPad purchase service modeled using WSMT 2.0. As noted earlier, the semantic web services means defining the semantic of web services using ontology languages which are, OWL, WSML. Further, we can say that the knowledge representation has been done using these languages and both OWL (Web Ontology Language) and WSML (Web Services Modeling Language) are available in various variants. The variants of OWL are; OWL-DL (Description Logic), OWL-S (Syntax or Full), OWL-L (Lite) [8]. The variants of WSML are; Core, DL, Flight, Rule and Full [9] and we've used WSML-Rule as our modeling language. We've modeled the ontologies for media-items in use (which includes audio media item, and video media item), credit-card ontology which specifies background knowledge for payment processing. Also, there is ontology for media download from outsourced service provider, which specifies knowledge background for listing the media, fetching the download link, and payments processing of the media download.

```
wsmlVariant
_"http://www.wsmo.org/wsml/wsml-syntax/wsm
l-rule"
namespace
{ _"http://smal.org/avpad/ontologies#"
 }

ontology DownloadOntology
importsOntology{ _"http://smal.org/avpad/o
ntologies#CreditCardOntology",
_"http://smal.org/avpad/ontologies#MediaOn
tology"}

relation addItem(ofType MediaItem, ofType
MediaList)

relation getSelectedItem(ofType MediaItem,
ofType MediaList)
relation downloadItem(ofType MediaItem)

axiom ListAllMedia
 definedBy
   forall ?item
    (?item memberOf MediaItem implies
     addItem(?item, MediaList)).
axiom downloadSelectedMedia
  definedBy
   getSelectedItem(?item, MediaList)
    and ?downloadItem[hasTitle
hasValue ?title] memberOf DownloadMediaList
     and downloadItem(?item).
axiom deductChargesForDownload
  definedBy
  getChargesForDownload(?item)
   and
creditCardCharge(?creditCard, ?price, ?dat
e).

concept DownloadMediaList subConceptOf
MediaItem
  hasUrl ofType (1 *) _string
```

Fig. 5. Web service ontology for download media-item

Fig. 5. shows the listing for download ontology which specifies the background knowledge of download media-items requested by the customer. Such requests are bound to be charged either from the credit balance with the customer account or the credit card. Each media-item presented by the media ontology has a price attribute and the DownloadMediaList, a SubConceptOf media-item adds a url to the media-item through which the user can download the selected media-item. The reference of the ontology is given in download service using the ImportsOntology. Also, the ontology references CreditCardOntology and

MediaOntology ontologies for payment processing after download and working media-items.

Other ontologies that have been identified in the system are

1) Shipping-ontology, which contains background knowledge of items that is to shipped to a customer. The concepts introduced in the ontology are ShipItem and ProductToBeShipped. The ProductToBeShipped is a pick-up item from the SMAL office and ShipItem is an item to be delivered at customer doorstep. The shipping ontology defines a relation between these concepts and creates an axiom between the two.
2) Media-ontology, which contains knowledge of media items used by the customer for download. The media-items have been defined for classification purpose by attributes artist, actor, title, album, etc. The ontology segregates media items in two categories, audio-items and video-items.
3) Credit-card Ontology, which specifies the knowledge of payment processing for the system described above. Also, we describe the axiom for not to overcharge the credit-card, so that the payment processing is always limited by the credit limit of the customer's credit card.

IV. Conclusion and Future Work

We present a formal description of a system using web services ontologies where two kinds of communications have been identified, viz., U-S and S-S. The identified ontologies for the presented system have been modeled using web services modeling toolkit. The User-Service has needs of traditional access-control which can be fulfill by policy-based access control, whereas Service-Service interface has altogether different needs of access control which needs state-of-the-art AAA framework for controlling access to various services interactions. We present the need of access control in web services using semantic web and identify that some rule-based access control system can be implemented for the given system.

We've discussed the system and various services present in the system and how they interact with each other. The model presented in the paper gives better view of various S-S and U-S interactions and lays foundation for the implementation of the access control for the system presented as a part of our research in future.

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