Policy Based Accounting for Web Services

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Abstract. In this paper, we propose a Policy based Accounting Architecture to integrate and automate the accounting functions and management for web services. The charging and accounting schemes currently used for web services are relatively simple. Users have either been charged a flat rate or charged based on the Internet connection time. A flexible accounting model is needed to cater to the varying needs of service providers while taking into accounts the user's spending limits and preferences for billing and payment. Policies will enable the service providers to describe the different charging schemes and implement the provisioning of accounting services to allow users to choose schemes that meet their needs. Policies expressed in a standardized way can be used to configure accounting processes to support the collection of information about resource utilization. Policies can also facilitate the distribution of accounting tasks among different entities. We have implemented and tested the proposed model for a on-line book store with web services having different charging schemes like fixed rate and varying rate based on usage of resources.

Keywords: web service, web service accounting, policy based accounting, flexible accounting, accounting architecture.

1 Introduction

Due to the increase in the usage of web services in E-commerce, the methods to provide flexibility in the accounting process have become one of the foremost objectives for the commercial use of web services. Customers need to pay for the usage of web service resources provided by different service providers. Each service provider would like to have a unique charging and pricing methodology. There is the need to provide for metering the web service usage and calculate the payment based on the charging patterns of individual service providers. The charging patterns may also vary depending on the categorization of users and the billing could be on a one-time basis or on a consolidated monthly, annual or periodic basis.

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Internet connection time. There is a need to presently integrate charging and accounting with the provisioning of web service by the service providers. The distributed nature of web service components provides challenges for web service accounting. Users may also use composite web services which may comprise of web services offered by different service providers. Hence accounting management systems are required to support a wide range of accounting functionality customized to the needs of the users. Accounting management function should be able to support usage based, content based and/or transaction based charging and accounting facilities.

We propose a Policy based Accounting Architecture to integrate and automate the accounting functions and management. Accounting based on service charging policies will be able to provide flexibility in accounting and enable accounting components to implement the metering and charging as per the service provider's requirements. Policies will enable the service providers to elucidate various types of charging schemes. Such scheme can be provisioned as accounting services that the users can choose based on their requirements. Policies expressed in a standardized way can be used to configure accounting processes to support the collection of information about resource utilization.

In this paper, we have proposed a comprehensive accounting framework which covers all aspects of accounting: metering, charging, accounting, billing and payment. We have presented a policy based approach for web services accounting that can accommodate different pricing schemes and charging based on resource usage. The proposed accounting architecture is given in Section 3. Section 4 outlines the implementation of the proposed framework for an on-line book store with fixed and varying tariffs. Section 5 concludes the paper.

2 Related Work

Authentication, authorization, and accounting (AAA) is a framework that is used to enforce control for access of various computer resources. Accounting policies can be implemented to determine usage of resources and bill the users appropriately. In this paper, we review the work related to the accounting function.

"Accounting, according to the definition of IETF in [1], is the process of collecting the resource usage information for the purpose of billing, trend analysis etc". An Accounting management framework should provide for metering, charging, accounting, billing, payment and auditing. Metering is the function of that collects the information flow regarding the resource usage of a certain service by the consumer and its usage [2]. "Charging is the process of calculating the cost of the services or resources usage according to the pricing strategies" [3]. Accounting is the process of filtering, collecting and aggregating the information of resource usage [2]. Billing is the process of using the accounting information to generate a bill that is delivered to a user. Payment defines a well-defined scheme of money exchange between the users and service providers. The act of verifying the correctness of the accounting process and procedures is termed as auditing [4].

We present the prior work related to web service accounting. A pricing model implemented as a web service focused on accounting for commercial web services [5]. The solution proposed shows how the use of Web services can be metered, and the resulting data used for subsequent accounting and billing processes. The metering and accounting model has been implemented using Service Level Agreements (SLAs). This model remains to be extended to include the other functions of accounting, billing, payment and auditing. Ge Zhang et al have presented Web Service Accounting system architecture and discussed and analyzed the issues and accounting entities related to web services [3]. This paper while very informative and exhaustive does not cover accounting protocols, inter-domain data collection and composite Web Services metering.

In their paper, N. Papatheodoulou, N. Sklavos have introduced the design of a generic AAA architecture for use in modern networks [6]. The authentication architecture is based on EAP (Extended Authentication Protocol), authorization is done by AAA server using X.509 certificates. The duration of a user's session is used to account and bill the network usage. They have proposed the use of the AAA protocol for a web based application scenario but implementation and results have not been discussed. Hasan et al have presented a paper using MobyDick AAAC architecture for Mobile Internet [7]. They have discussed a number of key features such as; tariff announcements, online charge indication, inter-domain support etc., for mobile Internet. These features with appropriate modification and extension could be applied for web service accounting.

Niklas Neumann and Xiaoming Fu have extended the Diameter protocol for web usage and called it the Diameter WebAuth [8]. It presents an AAA-based Identity Management Framework for Web Applications that allows integration of web based services into a Diameter infrastructure for authentication, authorization, credit-control and identity management purposes. This paper focuses on authentication but has suggested that the use of Diameter WebAuth could be extended for accounting also. Ming-Hua Lin et al have presented a flexible time-based pricing policy for charging Internet services [9]. They have discussed different pricing policy such as; duration-based, usage based, volume based etc. A multi-service billing has been developed using Tariff tables.

Igor Ruiz-Agundez et al have presented taxonomy for future Internet Accounting [2]. They have discussed in detail the services of metering, charging, mediation, accounting, pricing, billing and financial clearing [10].They have applied the taxonomy for Cloud Computing using SLAs and discussed various pricing strategies. Sebastien Decugis summarized the fundamentals of AAA architecture, "waaad" and also findings on Diameter limitations such as duplicate requests, hop-by-hop capability exchange mechanism and complexity [11].

3 Policy Based Accounting Architecture

In this paper we present an accounting architecture with mechanism to meter the use of a service's resources and store data generated by this metering activity. We

propose the use of an accounting policy to maintain the details of pricing and charging for web service usage. The user can query the policy to determine the pricing details of various web services and then decide on an appropriate web service. The users are charged on basis of the actual usage of the web services. The metered records are aggregated and summarized as accounting records. Bills are prepared from the accounting records and sent to the users for collection of payment.

The basic web service models the interactions between the three roles: the service provider, service registry, and service requestor as shown in Figure 1. The interactions involve publish, find, and bind operations.

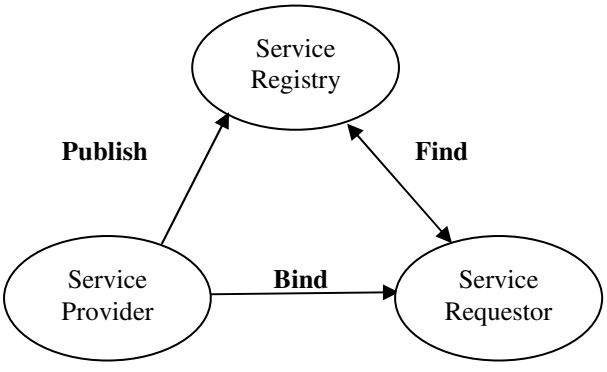

Fig. 1. Web Services Components

The Service registry is a searchable registry of service descriptions where service providers "Publish" their service descriptions. The Service provider defines a service description for the web service and publishes it to a service registry. The service requestor is a user or application looking for a web service that meets their processing requirements. The service requestor is a user or an application searching for a web service that meets their processing requirements. The "Find" operation is used to search the service registry for the required service. The "Bind" operation is used by the service provider to invoke or interact with the web service implementation.

Figure.2.shows the Policy based Accounting Architecture for the web service model. The principal component proposed is the AAA (Authentication Authorization Accounting) server that maintains the service charging policy and manages the usage data records and accounting records. The AAA client component is present at the service provider to collect the usage records and forward it to the AAA server.

The service provider also specifies the methods of charging for the usage of its web services and this policy is maintained at AAA server. The charging details are stored as Service Charging Policy (SCP) at AAA server. The service provider can have different charging policies for different users and can charge is calculated based on the usage time and/or usage of resources. The policy can also indicate a one-time usage charge or monthly and annual charging patterns.

The user, who wishes to access the service, will first send a request to the AAA server for details of pricing and charging of the particular service. The user will study the price details and may then decide to use the service.

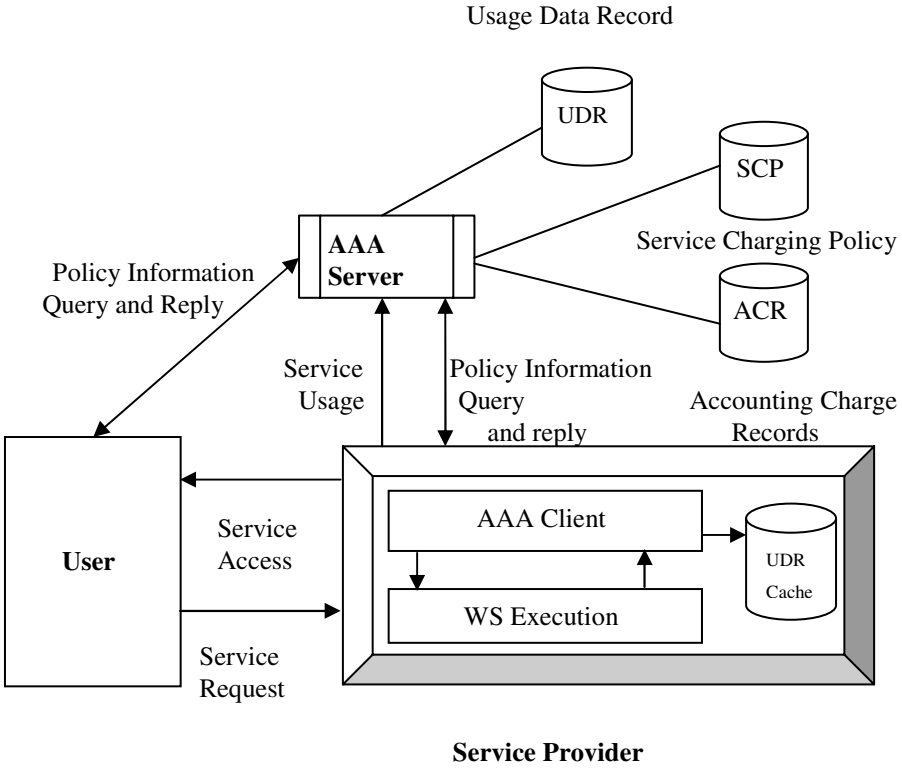

Fig. 2. Policy based Accounting Architecture

The user wishing to access a service will send a service request to the concerned service provider. The service provider will grant access to the requested service. AAA client will measure the service usage and forward the Usage Data Record (UDR) to the AAA server. We propose the use of a UDR cache to temporarily store and aggregate the UDRs before forwarding to the AAA server. In case of any network failure between the Service provider and AAA server, this cache will ensure that usage data is not lost and is maintained in the service provider till it is successfully transmitted to the AAA server.

The charges for usage of web service are calculated using the SCP and UDRs. The charging details are maintained as ACcounting Records (ACR). Bills are produced from the accounting records and sent to the users.

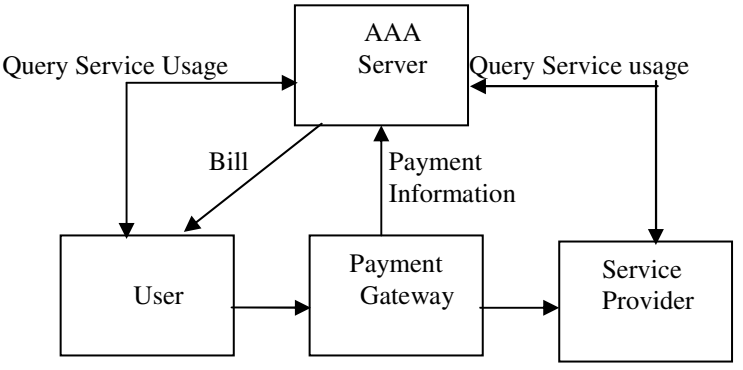

Fig. 3. Payment Process

The user's payments are collected using a third-party payment gateway as shown in Figure 3. The payment is sent to the Service Provider while the payment information is sent to the AAA server and updated in the ACR. The payment gateway provides a secure channel and enables electronic payment of bills. Payments received from users are matched against bills to determine the dues that are outstanding. Users can also query the AAA server and obtain accounting information. Accounting records can also be accessed for auditing and other statutory purposes.

4 Implementation

We implemented and tested the proposed architecture for an on-line book store. The book provides a web service based system that allows the customers to order the books online which will be delivered to their house. We assume that book publishers would register with the book store and provide the available book details. The book store would have links with delivery agencies for delivery of the books within one or two days.The web stores uses three services namely: "Search Book", "Book Enquiry" and "Book Order" services.

The Search Book service allows the user to search based on subject, author, title, publisher and publication year. The Book Enquiry service provides all the details of a particular book such as name, publication, edition, author, price and number of copies of books available. The Book Order service allows the user to place book orders.

Multiple books can be placed in a single order. The cost of individual books and the total amount is displayed. It also provides an option of reduction in price or offer based on their membership. Book delivery options are also displayed to allow the user to choose the mode of delivery and payment is calculated based on the distance between the book store and the destination.

Figure 4 depicts the relationship between the participating entities.

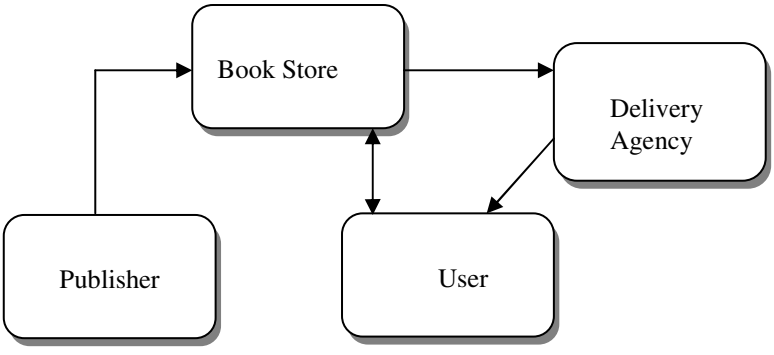

Fig. 4. On line Book Store

The charging pattern for each of the web service was designed as follows:

- The usage of "Search Book" service is charged based on the number of entries that are searched in order to retrieve the results.
- "Book Enquiry" service has a fixed charge as it directly fetches the book details.
- The "Book Order" service is charged on the number of books that are ordered.

There is a fixed charged for each book ordered. A variable charge is also calculated based on the service charge of the delivery agencies. We assume that the various agencies levy different service charges.

Usage of a particular web service is stored as a UDR. For example, usage of a single search query would be treated as a UDR. To create the accounting records, we categorized users as casual users and registered users. Casual users are billed for every transaction on a transaction-by-transaction basis.

The book store was implemented using ASP.NET. The policy file was maintained in XML format. The UDR and ACR records were maintained in a MS-SQL server. Exchange of policy information and other details was implemented using SOAP protocol. For registered users the transaction charges are aggregated and a single monthly bill is prepared.

The use of a charging policy enabled the implementation of different charges for various web service usages and for different user categories.

5 Conclusion

We have presented a comprehensive policy based accounting architecture for web service metering and charging. Accounting policies offer an easy implementation of different charging patterns offered by various service providers for service differentiation. Service providers can charge for the usage of their resources and

manage their pricing policy in a flexible manner. Multiple web usage scenarios can also be implemented in a simple manner. We plan to extend our work in preparing a more complete and extensive charging policy that covers all the different aspects and types of pricing and charging. As future work, we propose to work on standardization of the web usage record and accounting information.

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