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WEB SERVICES BILLING AND ACCOUNTING

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ABSTRACT

Accounting, according to the definition of IETF is the process of collecting the resource usage information for the purpose of billing, trend analysis etc. This paper presents an integrated billing, accounting and charging system for web service accounting. The ability to generate revenue based on differentiated services is critical to the future business success for service providers. Current AAA architectures, protocols, and implementations are unable to cope with heterogeneous application scenarios and requirements related to different provisioning of services. The proposed system aims to automate the process of billing and accounting for web services. Charging and accounting policies have been used to specify the pricing and accounting options for different services and users. Standard IPDR format has been proposed to define the bill and payment formats. The proposed design has been implemented and tested with a sample application.
Key words: *Web service Accounting, Web service Audit, Web service bill, IPDR format*

1. INTRODUCTION

Web services have become a critical component of commercial business applications. Web services provide interoperability using XML based communication among applications residing in a heterogeneous environment [1]. Examples of web service usage include stock trading, on-line reservation and ticketing, auction and retail applications. To fully satisfy the requirements of business applications, key challenges such as, security, scalability, transactional support, and accounting have to be addressed.

The charging and accounting schemes used in IP and in Telecommunication world are relatively simple, with service providers charging the users on the basis of flat-rate subscription schemes, call duration or the Internet connection duration [2]. For web services, the metering and accounting model has to take a higher level approach than merely measuring traffic between IP-addresses or counting the number of e-mails sent. Web services are described and published by service providers on standard registries on the Internet. The service providers discover and dynamically invoke such web services. There is a need to efficiently measure the usage of web services invoked by service requesters.

Internet Engineering Task Force (IETF) and International Research Task Force (IRTF) have conducted a series of study on Authentication, Authorization, and Accounting (AAA) for the Internet [3], [4], [5]. Accounting has been defined as the collection of resource consumption data for the purposes of capacity and trend analysis, cost allocation, auditing, and billing [3]. Accounting management requires that resource consumption be measured, rated, assigned, and communicated between appropriate parties. AAA infrastructure consisting of a network of cooperating generic AAA servers communicating via a standard protocol which supports a wide variety of applications was proposed. The protocol would need to operate in a multi-domain environment with multiple service providers. The applications requiring AAA services would each have their own unique needs and application specific knowledge may be required to handle the specific service functions.

Each web service provider to be competitive may have different offerings of web services; some of which may be charged and some

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may be free. Service providers would have to offer usage based pricing scheme and bill service requesters only for services they have used. The charging and billing may not only be for the web services used but also on the basis of resources or content accessed during execution of the web service. Audit trail of the billing records would have to be provided for verification by users, service providers and third party auditors. The challenge is therefore to develop an integrated accounting system where the key players and support systems can exchange usage, provisioning and control information with each other [6].

This paper focuses on web service accounting which covers the process of billing, payment and auditing. The rest of the study is organized as follows. Section 2 discusses the work related to web service accounting and billing. Section 3 discusses in detail the design of an integrated accounting module. Section 4 outlines the implementation of billing and accounting for a sample application E-book reading with fixed and varying tariffs. Section 5 concludes the study.

2. RELATED WORK

The effectiveness and the efficiency of accounting models are crucial in implementing viable pricing and economic based resource allocation models in the Internet [7]. Research has primarily focused on pricing models while accounting architecture requires standardization. Since there is relatively less work with reference to web service accounting, in this section we also discuss work related to accounting and billing for the Internet, telecommunication and cloud computing services.

Zseby et al describe policy-based accounting as an approach to providing flexibility to accounting architectures [8]. Accounting policies described the configuration of an accounting architecture in a standardized way. This work proposed the use of AAA protocol for accounting the usage of resources expressed in policies. This work does not cover billing, payment, accounting and auditing.

Christoph Rensing et al (2005) have performed a survey of AAA for the Internet and have suggested a new generic policy-based approach from connectivity to content services in an Internet service model [9]. The architecture presented includes pricing, charging, billing and auditing. The author has also aimed to differentiate between support services and user services. Implementation details have not been provided.

Igor Ruiz-Agundez et al (2010) have presented taxonomy for future Internet Accounting. The taxonomy classifies all the functions involved in accounting in a hierarchical structure, representing their behavior. The functions include metering, charging, mediation, accounting, pricing, billing and financial clearing [10].

Molina et al (2009) have discussed the technical issues involved in bilateral accounting. Their bilateral accounting model measures resource consumption at both the consumer and provider sites and allows both consumer and provider to independently measure resource consumption and verify the accounting process for Internet services. The research is primarily focused on pay-per-use service of Internet Data Centers (IDC). They have considered the three basic services of storage, bandwidth and compute power to remote customers over the Internet [11]. Their work does not address web services.

Igor Ruiz-Agundez et al (2010) have studied the billing needs of Internet Services [12]. They have emphasized billing as one of the most important factors necessary to ensure the economic sustainability and the revenue management of organizations that offer such emerging services. They have presented different pricing schemes such as pre-paid, post-paid, time-based, volume-based, QoS-based, session-oriented or content-based.

The consumer centric accounting model has been proposed by Ahmed Mihoob et al (2009) for pay-per-use cloud service. Their model proposes that data needed for calculating billing charges can be collected independently by the consumer or by a trusted third party (TTP) by running their own measurement service. As service users can verify the charges billed, such model would have the desirable property of openness and transparency [13]. They have illustrated their idea by considering the accounting model of a simple storage service.

Sekar et al (2011) have discussed the need for a systematic approach for verifiable resource accounting and have presented the challenges for releasing such a framework. Their work focuses on verifiability; cloud customers can be assured that they have been charged for resources actually consumed and that their charging is as per the agreed policy. This would increase the customer level of trust of the service provider [14]. Performance impact and overhead for monitoring

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usage levels and accidental leak of private information have not been addressed.

Igor Ruiz-Agundez et al(2011) presented a flexible accounting model for cloud services in a comprehensive and homogeneous manner [15].They have proposed the use of Internet Protocol Detail Record (IPDR) which is an open, vendor independent standard, defined in the Network Data Management-Usage (NDM-U) specification, to simplify billing and usage recordkeeping for any type of services. IPDR and jBilling accounting platform has been proposed to provide flexibility to fit any pricing scheme for the cloud services. Their model has been demonstrated using an IaaS (Infrastructure as a Service) application.

Bhushan et al (2002) has proposed a federated accounting architecture for business-to-business (B2B) management to support charging and billing applications. The architecture aims to be both open and adaptable and is based on standardization work going on in TM Forum (TeleManagement Forum), IPDR (IP Detail Record), IETF and ETSI (European Telecommunication Standardization Institute). Service usage information is modeled on IPDR documents to produce charges and bills. Dynamic Federated ORganisations Management (FORM) architectural framework has been presented for usage based, application specific charging and billing in a multi-Service Provider environment [6].

Bella et al have examined how IPDR standard can be used to improve the fraud detection process [16]. They have said that billing records constitute the main source of information for fraud management systems. They have reviewed the limitations of the current billing systems for Next Generation Networks (NGN) for fraud detection and have looked at the advantages of using IPDR to overcome these weaknesses.

A secure and non obstructive billing system called THEMIS has been proposed by Ki-Woong et al (2013) for cloud computing environment [17]. Their system proposes the use of a third party Cloud Notary Authority (CNA) for the supervision of billing. The cloud notary authority generates mutually verifiable binding information that can be used to resolve disputes between a user and a cloud service provider. To provide forgery-resistive SLA monitoring, an SLA monitoring module has been proposed for measuring and logging.

Niklas Neumann et al (2008) have extended the existing network-based AAA mechanisms for web usage. They have presented Diameter WebAuth, an AAA-based identity management framework for web applications [18].This paper focuses on authentication but the authors have suggested that their work can be extended for accounting.

Ortega, and Abdullah, 2008 have proposed that in web service environment, the service providers require to formulate QoS aware services in order to achieve maximum revenue from their services [19]. Their work focused on quality aspects and design for end to end solution comprising of testing and auditing.

3. WEB SERVICE ACCOUNTING SYSTEM

Accounting management involves the functions of metering, charging, accounting, billing, payment and auditing [11]. In our earlier work, we had proposed WS-PACT, a policy based accounting architecture for the integration and management of the accounting functions for web services [20]. We have also presented a generic and a comprehensive charging policy methodology for web services to accommodate different pricing schemes and charging based on resource usage [21].

The issue of web service metering has also been addressed as earlier work [22]. RADIUS protocol was modified and extended to meter the usage of web services by service requesters. The web service usage details are stored in the Usage Data Records (UDR) database. The usage data is recorded and stored in standard IPDR format. Details of service user, time of usage, volume and quantum of usage is maintained.

This paper focuses on billing, accounting and audit. The integrated billing, accounting and charging modules for web service accounting is presented in Figure 1.

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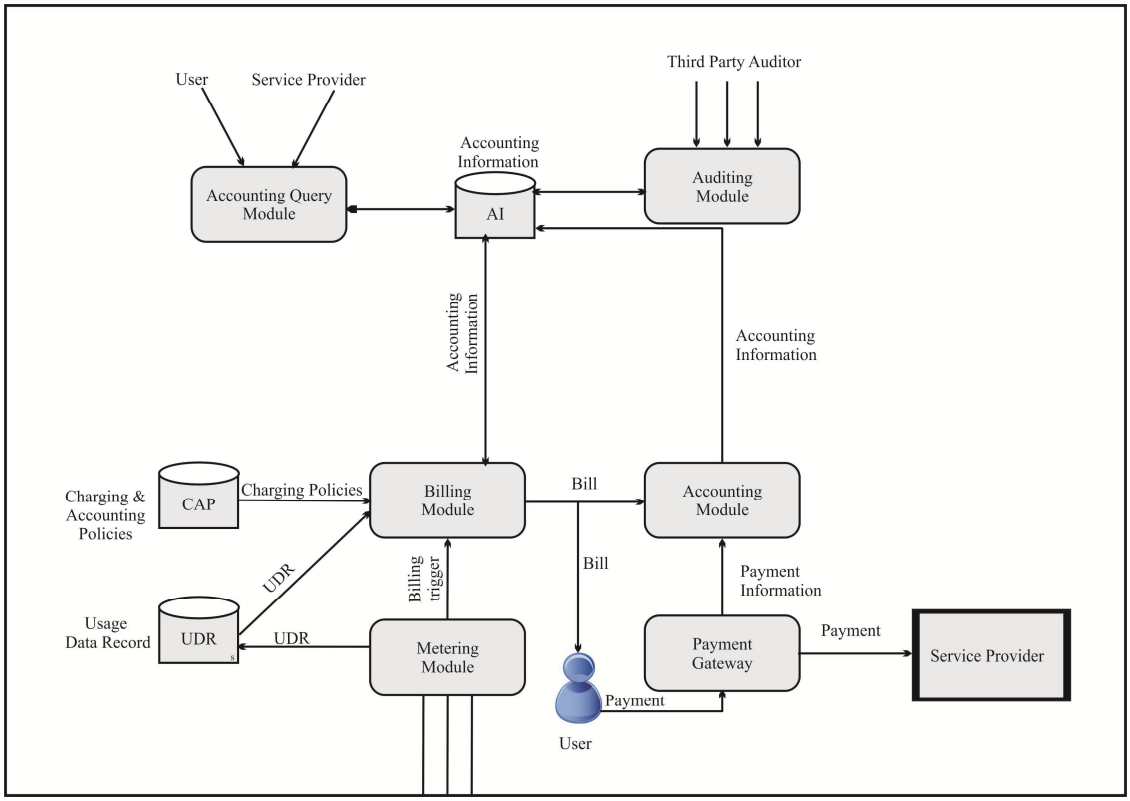

Figure 1: An Integrated Accounting Module

The charging and accounting policy is maintained in the Charging and Accounting Policies (CAP) database. Each service provider can offer different pricing schemes for the same service. The pricing schemes could be pay-per-use, subscription, pre-paid, post-paid etc. The user would choose a specific charging policy for accessing a particular web service. The user charging preferences and the billing mode would be maintained in the CAP database. The Accounting Information (AI) database would contain the details required for billing the user. These details would include user address as well as billing address.

The billing module automates the function of raising bills on the users. The billing mode can specify, for instance, whether the billing is pay-per-use, monthly, bi-monthly, quarterly, annually etc. Bills or invoices would be prepared using the information from CAP, UDR and AI databases. The applicable tariff scheme for a user would be extracted from CAP database and the charging is done for the service usage obtained from UDR database. The address and other details for raising a bill would be obtained from the AI database. Different types of billing can be supported by the billing module. The user could opt to get a single bill for each service provider or ask for a consolidated bill for usage of services of all service providers.

It is proposed to record the bill using the standard IPDR format. The IPDR Document hierarchy allows an IPDRDoc to contain a header and multiple IPDR elements [23]. The details specific to a service can be defined as IPDR elements in the document.

The IPDR document format is used to record details of Who (the bill was raised); what (service usage measures and quantities); When (Start Time/End Time). The bills would be raised in the administration domain of the service provider. For the purpose of billing, it is assumed in this paper, that the user and the service provider belong to the same administration domain. Figure 2 shows the graphical representation of the different IPDR elements and their relationship.

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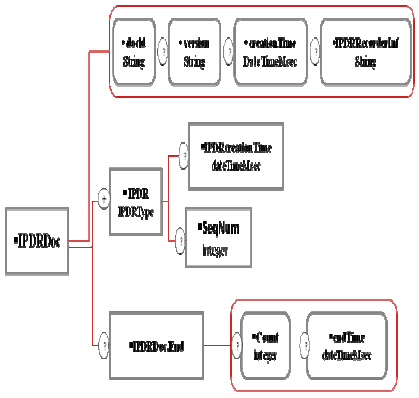

Figure. 2: IPDR Elements

The XML document of a sample bill generated by the system is given in Figure 3.

```
<IPDRDoc>
 <docId="g8e0ca84-2222-11b2-85ef-
fd66246596bb"
 Creation Time="2013-12-03T11:10:00Z"
 IPDRRecorderInfo ="BILL"
 version="3.1">
<IPDR>
<IPDRCreationTime>2013-12-03T  10:10:00Z
</IPDRCreationTime>
<seqNum>1</seqNum>
<Username>XYZ </Username>
<UserID>01 </UserID>
<Web Service Provider Name>
     ABC</ Web Service Provider Name >
< Web Service Name >
   E-book Reading </ Web Service Name >
<Bill Number> B1 </ Bill Number >
< Bill Date> 2013-12-01</ Bill Date >
< Bill Address >
    <House Number>410 </ House Number >
     <City> Chennai</ City ></ Bill Address >
< User Address >
  <House Number> 410< House Number >
   <City> Chennai</ City >
</ User Address >
< Billing Period >
    <Start Date> 2013-11-01</ Start Date >
    < End Date > 2013-11-30</ End Date >
</ Billing Period >
< Total Amount > 1000 </ Total Amount >
<Billing Mode >Monthly</Billing Mode >
</IPDR>
<IPDR>
<IPDRCreationTime>2013-12-03T
10:10:00Z</IPDRCreationTime>
<seqNum>2</seqNum>
<Charging Plan>Subscription</Charging Plan>
<Bytes Transferred_MB>
        5 </ Bytes Transferred_MB >
<Total Usage Time>30</ Total Usage Time >
<Previous Balance> 0.00</ Previous Balance >
<Total Amount>1000 </ Total Amount >
<Outstanding Amount>
1000</ Outstanding Amount >
</IPDR>
</IPDRDoc>
```

Figure. 3: A record in IPDR format showing bill for E-book reading service

The header contains details such as docID, version, creation time and service billing information such as user ID, service provider ID, billing address, billing period etc. The IPDR elements would denote the billed items and would contain details such as charging plan, total usage time, bytes transferred, total amount, previous balance, outstanding amount etc.

The function of the accounting module is to maintain the bills, update the payments and match the bills with payments to determine the payment outstanding from the users. Payment gateway is proposed to receive the payments from the users. The money payment would reach the service providers through their banks while the payment information would be updated in AI. The XML document of a sample payment generated by the system is given in Figure 4.

```
<IPDRDoc>
 docId="g8e0ca84-2222-11b2-85ef-
fd66246596bb"
 Creation Time="2013-12-10T04:15:03Z"
 IPDRRecorderInfo ="PAYMENT"
 version="3.1">
<IPDR>
<IPDRCreationTime>2013-12-10T
 04:15:03Z </IPDRCreationTime>
<seqNum>1</seqNum>
<Username>XYZ </Username>
<UserID>01 </UserID>
< Web Service Provider Name >
   ABC</ Web Service Provider Name >
< Total Amount > 1000 </ Total Amount > <
Payment Mode>ECS</ Payment Mode >
</IPDR>
</IPDRDoc>
```

Figure. 4: A record in IPDR format showing payment

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10th July 2014. Vol. 65 No.1

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The header contains details such as docID, version, creation time and service payment information such as user name, user ID, service provider name etc. The IPDR elements would denote the mode of payment and total amount paid. The bills would be matched with the payments to determine outstanding payments that are due from the users. The accounting module would periodically generate the due/overdue details along with payment requests to the users.

Auditing is the process of verification of the correctness of procedures regarding the service usage. Auditing is typically carried out by a third party auditor. Auditing of accounting records provides verification and proof of the use of resources and for customer charges. Audit trail of accounting information provides a valuable tool for the auditor. User accounting records (UAR) and UDR would provide valuable information to determine service usage, verify billing and match payment received with bills raised. Service provider and the users can use the Accounting Query module to raise accounting queries regarding charging for their service usage as well as payments made by them.

4. IMPLEMENTATION AND RESULTS

Implementation of proposed integrated accounting module for web services has been carried using a sample E-Book service application. The service is offered by multiple service providers with different provisions and different charging policies.The user sign-up with AAA server and provides details of their user name, billing address, contact address etc. These credentials are stored in AI. The service usage information is stored in UDR in IPDR format. The charging and accounting policies selected by individual users are maintained in the CAP database.

The billing trigger is sent to the Billing module by the metering module. This trigger is generated based on the accounting policies chosen by the user. For instance, if the user has selected "pay-per-use" option, the bill has to be generated at the end of every usage session. In case of pre-paid option, the bill would be raised and payment adjusted with the available balance. The bill along with the balance available would be sent to the user.

The metered resource usage data (UDR) and the user selected charging scheme from CAP database are the accounting details in AI are used to generate the bill. For example, a user may have opted to pay based on time duration for online book reading service. The amount is calculated based on the time duration available in the UDR and the pricing stored in CAP. The user name, address and other details for generating the bill is obtained from AI to raise the bill. Bills can be generated for single usage or monthly, bi-monthly, quarterly, half yearly or annual basis as per the agreement made between users and service providers. A sample screenshot of bill generated in IPDR format is shown in Figure 5.

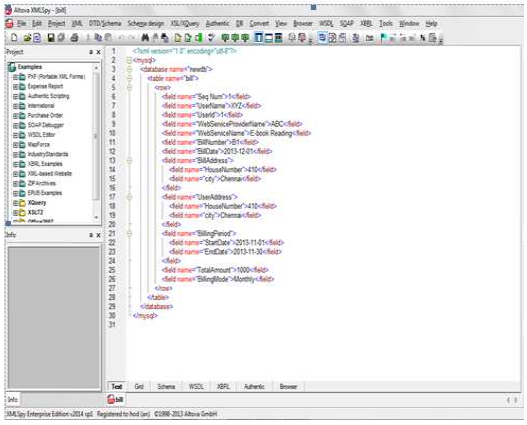

Figure. 5: A sample screenshot of bill generated in IPDR format

Snapshot of payment record in IPDR format is shown in Figure 6.

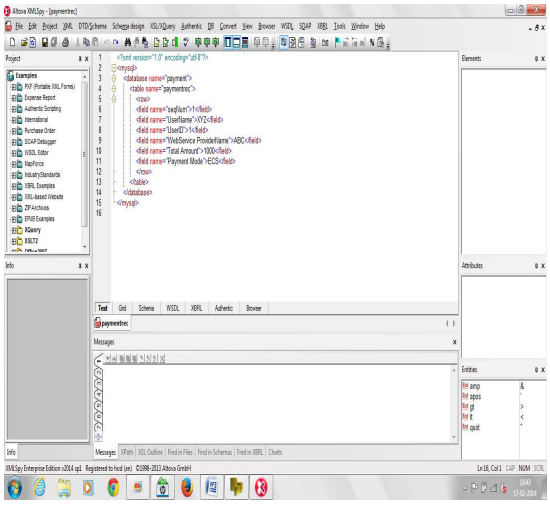

Figure. 6: A Snapshot of payment record in IPDR format

The usage, bill and payment data are all maintained in standard IPDR format using XML. Stylus Studio® X14 XML Enterprise Suite has been used to query the usage and accounting

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information. The snapshot of a query on a specific usage by a user is shown in Figure 7.

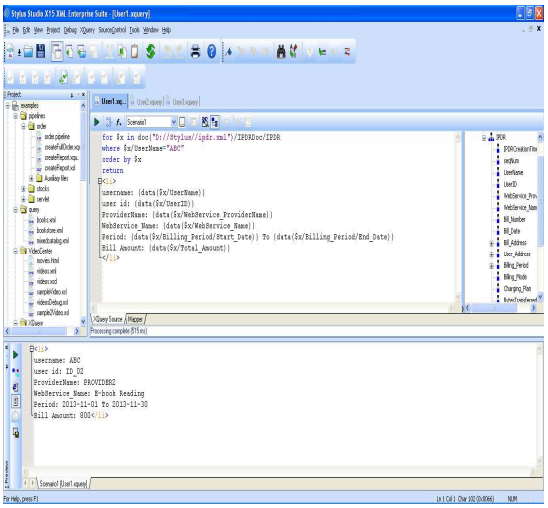

Figure. 7: A snapshot of a query on a specific usage by a user

Figure 7. Shows the results of query giving the details of web service used, service provider, duration of usage and bill amount. The snapshot of a query giving billing and payment details for a specific usage is shown in Figure 8.

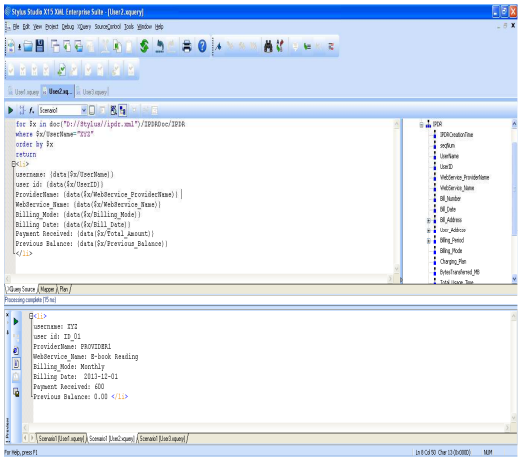

Figure. 8: A snapshot of a giving billing and payment details for a specific usage

Figure 8 shows the results of query giving the summary information of billing amount, payment received and dues outstanding by a user to a service provider. The snapshot of a query giving accounting information for a service provider is shown in Figure 9.

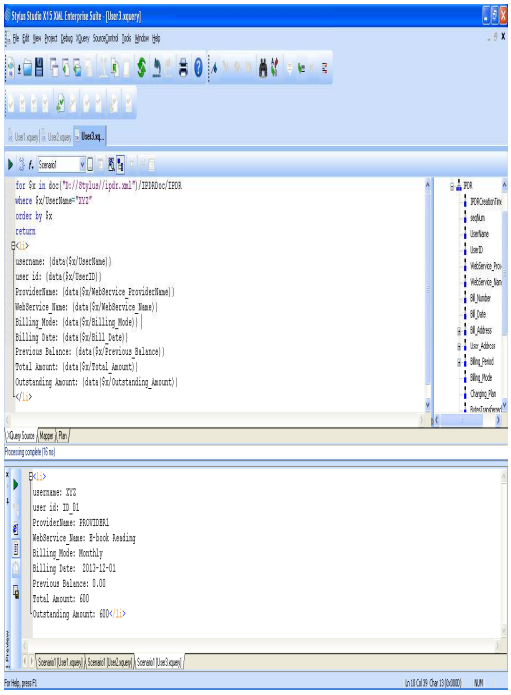

Figure. 9: A snapshot of a query giving accounting information for a service provider

Figure 9 shows the total bill amount, payment amount and dues outstanding.

5. CONCLUSION AND FUTURE WORK

More and more enterprises are migrating their business processes to web service based distributed applications. Commercial web service models are required to support Business-to-Business (B2B) and Business-to-Consumer (B2C) transactions that measure web service for the purpose of charging and billing. There is an increasing need for AAA services to also include Charging and Auditing (AAAAC). This paper has presented an integrated system for billing, payment, accounting and audit for web services. The proposed system aims to automate the process of billing and accounting for web services. Charging and accounting policies have been used to specify the pricing and accounting options for different services and users. Standard IPDR format has been proposed to define the bill and payment formats. The proposed design has been implemented and tested with a sample application. This work assumes that the user and service provider belong to the same administration domain. As future work, it is proposed to address inter-domain accounting and for pre-paid charging scheme, usage metering and accounting have to be integrated. As and when

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the service is used, accounting for the service has to be done concurrently as per the charging pattern. Usage of service has to be stopped when the pre-paid amount is exhausted and the user has to be altered to make payment to continue using the service.

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