CHAPTER 3

WEB SERVICE ACCOUNTING ARCHITECTURE

Accounting is an important basic service for commercial business applications. The accounting system must efficiently and effectively collect and store data about web service usage and transactions. Batch accounting refers to accounting information that is saved, until it is delivered at a later time. Real-time accounting refers to accounting information that is delivered concurrently with the consumption of resources (Goranthala et al 2012). Typical information that is gathered in accounting includes the identity of the user or other entities, the nature of the service delivered, when the service began, and when it ended.

The accounting information would be able to provide a chronological record of usage and related billing and payment transactions, for accounting and audit purposes. The accounting information can also be used to generate reports in the form of financial statements and managerial reports for decision making. The management framework should be able to handle the accounting service life cycle activities in a customer-oriented as well as service-oriented manner.

Accounting, according to the definition of IETF, is the process of collecting the resource usage information for the purpose of billing, cost allocation, auditing and trend analysis (Zhang et al 2005). The accounting system should meet the requirements of the web service providers and support a wide-range of customization of the provided accounting functionality,
according to the customer needs. The web service’s users have to be charged for their usages of services according to pre-defined and agreed-upon pricing strategies. The service providers would raise bills on the service users for the cost of services provided and collect the payment. This includes, among others, the support of complex-structured, usage-based, customer-individual tariffs, as well as the support of increasing dynamic change in management activities.

Web services are offered by different service providers. Web services may be single or composite. An atomic service is a single self-contained service that does not invoke any other services. Multiple web services can also be combined into a composite web service to deliver the required business functionality (Chafle et al 2004). In a composite web service, the individual services could be offered by different service providers. The Accounting system should provide facility for the different resource owners to account for the usage of their various resources shared among multiple organizations. The accounting platform should enable the various service providers to collaborate to provide the users with a uniform billing and accounting service. The challenges associated with composing and pricing web services have been discussed (Gunther et al 2007).

3.1 RESEARCH APPROACH

The first step in web service accounting is the requirement of a generic accounting architecture with a mechanism to meter the usage activity and provide other services, such as billing, accounting and auditing. The proposed research work aims at developing a generic policy based accounting architecture, to integrate the accounting functions and their management. Accounting based on policies will be able to provide flexibility in accounting, and enable the accounting components to be implemented in a manner, that would satisfy the needs of both the service providers and service clients.
The research work aims at automating the accounting functions, such as charging, billing, accounting and auditing. Charging is the process of calculating the cost of the services or resource usage, according to the pricing strategies and accounting information. The research work proposes to provide the facility to specify and support flexible charging / pricing models using policies. Charging policies will enable the service providers to elucidate various types of charging schemes, based on the time, content or transactions. The users would be able to select services that meet their cost and functional requirements.

Charging and metering have to be integrated with the usage of web services. The research work aims at providing a solution to automate the metering of web service usage, and also to store the data that is generated by the metering activity. The research work proposes to define and use a standard format for recording the measured service usage data. The metered data would be used to compute the payments due from the service users according to the pricing agreed upon by the service providers and users.

Billing is the process of converting the gathered charging information of a customer into a deliverable bill (Stiller et al 1999). This research work aims to develop the billing module to automate the function of raising bills on the users. It is proposed to maintain information regarding the billing mode, period, and other user information required, for raising bills on the service users.

The research work aims to develop an accounting module to record payments received from the service users. Such payments can be matched against bills to determine dues or outstanding. The accounting data would provide provision to generate various reports to support decision making for effective and efficient financial management. It is also proposed to provide an
auditing facility to view the trail of the usage, billing and payment for verification by the users, service providers and auditors.

3.2 ACCOUNTING ARCHITECTURE FOR WEB SERVICES

A generic accounting architecture has been proposed to automate the various accounting functions for web services. The proposed architecture serves to distribute the collection of web service usage and provide for metering, charging, billing, and payment, accounting, and auditing. The proposed work aims to integrate and automate the various accounting activities. Figure 3.1 shows the proposed architecture.

Figure 3.1 Accounting Architecture for Web Services
The principal component in the proposed architecture is the AAAAC server which would be responsible for the management and the overall co-ordination of the accounting activities. The server would store and manage the charging and accounting policies of the service providers. The Usage Data Records (UDR) and Accounting Information (AI) would also be maintained at the server. Charging and Accounting Policies (CAP) would enable service providers to define various types of pricing schemes, and maintain them in the CAP database. Service providers would manage the Lifecycle of the policies from creation through modification to their removal, when no longer valid. Policies would be enforced by the AAAAC server and clients.

The AAAAC client component at the service provider would interface with the AAAAC server and provide details of the web service usage. The AAAAC Client component in the service provider would measure the service usage, and forward the details to the AAAAC server. The usage information is stored at the AAAAC server in the UDR database. An UDR cache has been proposed at the service provider to temporarily cache the usage records, before forwarding them to the AAAAC server. This would also ensure that the usage records are not lost due to network or other failures.

The service usage and accounting process would happen in the following manner. The service providers would define different charging policies to offer different usage and pricing patterns for the web services. The user or client, who wishes to access a web service, would first send a request to the AAAAC server to obtain details of pricing of the particular service. The user can then decide to choose a particular charging policy. For example, the user may decide to go with a pay-per-use charging option. If the user intends to use the service over a period of time, he may prefer to subscribe for monthly or other periodic usage. The user pricing options as agreed with the
service provider would be stored and maintained in the AI database by the AAAAC server.

Whenever, the client uses the service, the AAAAC Client component in the service provider would measure the service usage, and forward the usage information to the AAAAC server. The AAAAC client would keep track of the user’s activities while accessing the web service resources, including the amount of time spent in the network, the amount of data transferred during the session and specific service functions accessed. For example, a web application may offer the facility to download information. The use of the download function, amount of data downloaded, and session time, would have to be recorded for charging purposes.

The billing process is automated, and bills would be raised as per the charging and accounting options agreed upon by the service provider and the users. The bill generated would be stored in the AI and would also be sent to the users for payment. The details of payment received from the users would be maintained in the AI database.

The accounting module would enable the payments received to be matched with the bills raised, and to determine the outstanding dues or receivables from the service users. Follow-up statements can be periodically generated to inform the users of outstanding dues. The accounting information can be accessed by the users to query their usage, bills and payment details. The accounting records can also be accessed by third party auditors for statutory auditing and other purposes.

The proposed architecture is scalable and would be capable of handling increases in web services and users. As the number of web services increases and the usage instances become high, multiple meters can be
implemented to meter the usage statistics. Multiple AAAAC servers can be used to co-ordinate and manage multiple clients.

3.3 CHARGING MODULE

Charging is the function that calculates the costs for a given resource consumption (Atanasov et al 2012). The use of policies has been proposed to define the different pricing schemes of the service providers. Policies provide for ease and flexibility in defining the charging patterns. They can be managed independently of the business function (Gleason et al 2005).

More than one policy can be associated with a service, and conversely, the same policy could be associated with more than one service. The Service functionality may change over the lifetime of a service, and hence, the charging for the service is also likely to change. The use of policies provide for ease of update of the changes. The pricing patterns can also be varied depending on user categorization. Policies facilitate service consumers to query the policies to know the pricing details. The users can then decide on a suitable pricing option for the usage of the web services.

3.3.1 WS-Policy

The WS-Policy standard has been proposed to define the charging and accounting policies. WS-Policies are machine readable and facilitate the automation of the accounting processes. The WS-Policy provides a standard way to describe the properties that characterize a web service (Belouadha et al 2010). The WS-Policy framework provides a single policy language to express and evaluate all policy assertions. The WS-Policy data model is given in Figure 3.2 (http://www.w3.org/TR/WS-Policy-primer #policy data model)
The WS-Policy defines policy as collection of policy alternatives, with each policy alternative being a set of policy assertions. An assertion is defined as an individual preference, requirement and capability of a web service. Multiple policy assertions are grouped into policy alternatives, formed by surrounding the assertions with the `<wsp:All>` or `<wsp:ExactlyOne>` element. `<wsp:All>` expresses that all assertions included in the policy alternative must be satisfied, whereas `<wsp:ExactlyOne>` requires that exactly one of its assertions be satisfied.

### 3.3.2 Charging and Accounting Policy

Charging and Accounting Policies (CAP) have been proposed to define different types of charging patterns and usage. Policies facilitate specifying the varied pricing options of different service providers. The users can query the policies to know the pricing options and can select the web
service that is appropriate for their use. CAP is illustrated with a sample E-book application, developed using web services. Sample policies which define the various pricing schemes for this application have been explained.

The E-book application provides e-books for reading on-line. The application also provides facility for viewing and downloading the e-books and reading offline. The list of current e-books are displayed online, and details of the book, such as, the title, author, publisher and year of publication are provided. The books displayed are changed every month, and the old books are archived. The application provides capability that allows the users to download the book displayed online or from the archives.

The Option is provided to allow the users to rate the book they have read, on a scale. User ratings are also displayed to enable users to get an opinion of the books on display. The facility is provided to allow the users to comment/review the books they have read. The sharing facility is provided to allow the users to share the book with their friends. Personalized recommendations make it easy to discover new books, and share with friends. The pre-order facility is also assumed to be provided. The users can pre-order books that are yet to be released.

The application involves the use of multiple web services for: registration, search, read, download, payment, sharing, comment/review, download from archival, rating, and pre-order. The application is considered to be implemented with the use of both atomic and composite web services. Composite web services are used to combine multiple actions into a web service offering. For example, composite web services would allow a member to select and download books displayed online as well. Composite service can also be used to combine selection and, download of books from the archives.
The E-book application is further explained to illustrate the use of varying charging options. The application provides an option to allow the users to pay either on a time basis or on a content basis. Time would mean the Internet time or session time, for which they remain connected while using the service. Charging for content would mean that the charges would vary, depending on the specific content accessed as well as the quantum of resources (bytes of data) accessed. Pricing could also vary depending on specific functions accessed, for example, the download function.

All users are required to register, to use the E-Book application. The users have been classified into two types: member or non-member. Different charging options are provided for members and non-members.

3.3.2.1 Pricing schemes for members

Users who register as members are required to pay a fixed amount towards membership fee. Users who become members may enjoy special privileges and discounts and certain functions may be restricted to only members. Membership could also be offered free by service providers or can be offered for a limited time period by some service providers to attract new users.

Different types of payment modes are offered to members: pre-paid and post-paid. In pre-paid, users are required to pay in advance. The advance amount is adjusted against the web service usage. When the amount is used up, then the user would have to deposit additional amounts for the continuing use of the web services. In post-paid, billing for service usage for members could be periodic with the option for a monthly, bi-monthly, quarterly and half-yearly or annual basis, as shown in Figure 3.3.
Figure 3.3 Payment Modes for Members

For example, the membership amount could be paid on a monthly, bi-monthly, quarterly, half-yearly or annual basis. The membership fee could vary for the different payment options. A sample charging options for membership fee is given in Table 3.1.

### Table 3.1 E-Book Sample Membership Fee

<table>
<thead>
<tr>
<th>Payment Mode</th>
<th>Amount in INR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monthly</td>
<td>100</td>
</tr>
<tr>
<td>Bi-monthly</td>
<td>150</td>
</tr>
<tr>
<td>Quarterly</td>
<td>225</td>
</tr>
<tr>
<td>Half-Yearly</td>
<td>400</td>
</tr>
<tr>
<td>Annual</td>
<td>700</td>
</tr>
</tbody>
</table>

WS-Policy for the sample membership fee is shown in Figure 3.4.
The charging policies represent the membership schemes of Provider1. The currency that is to be used for payment, for example, Indian Rupees (INR), could also be specified in the policy. The default currency and exchange conversion procedures can also be specified in the policies. The different functions available to the members are now explained.

- **Search function**: Members can search for specific information or books. The archives could be searched for the availability of a specific book. Different search options are provided, such as, search on basis of author name, title etc.

- **Read access**: Members can read any or all of the books displayed. They can log-in any time, 24/7, and read any of the
books on display, any number of times. They can choose to read from the beginning or from any page or chapter in the book.

- **Download access:** Members can download e-books displayed as online as from the archives. Option is provided to allow members to download an entire book or a few chapters or pages. The charges would vary based on the numbers of pages or on the number of bytes. This would be specified using policies. The members can also choose the format to download the books, for example, “.pdf” format. Different formats for downloading can be made available with different formats being charged different amounts and these could be specified using policies.

- **Read/download the books from archival:** Members can read/download the books that are archived. Books are archived every month.

- **Read/download books on special requirement basis:** Members would also be able to read/download the book that is not available with the provider. The requested books would be procured and made available to the member.

- **Additional perks:** It is possible to use policies to provide additional benefits or perks to members. This could include discount coupons and other special offers which may be open for limited periods.

- **Rating:** Members would also be able to rate a book. For the top rating, the members are provided with discounts on read access from 6.00am to 8.00am.
- **Comment/review**: Members can comment/review the books they have read. For the best comment/review, the members are awarded with “Free subscription” for a month’s period.

- **Sharing**: Members would also be able to track books in the areas of their interest by setting their preferences for “My Books,” a new tracking feature. They can clip articles and photos for future reference, and can share them with a friend.

- **Pre-order**: Members would also be able to pre-order a book. Special discounts may be provided to members who pre-order books prior to its release.

![Figure 3.5 E-Book Subscription Schemes for Members](image)

Different subscription options are considered to illustrate different pricing schemes offered to members, are shown in Figure 3.5.

In Fixed scheme option, a fixed amount would be collected towards web service usage for a specific period. The amount payable would vary, depending on the payment mode as explained for membership fee. Sample fixed rates are given in Table 3.2 and the charging policy is shown in Figure 3.6.
Table 3.2 E-Book Sample Membership Fixed Fee Options

<table>
<thead>
<tr>
<th>Payment Mode</th>
<th>Amount in INR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monthly</td>
<td>500</td>
</tr>
<tr>
<td>Bi-monthly</td>
<td>800</td>
</tr>
<tr>
<td>Quarterly</td>
<td>1200</td>
</tr>
<tr>
<td>Half-Yearly</td>
<td>1800</td>
</tr>
<tr>
<td>Annual</td>
<td>3500</td>
</tr>
</tbody>
</table>

It can be noted from the policy that the service provider for this policy is “Provider1”. Users under this payment category have unlimited access to reading books but limited access to functions. For example, they would not be permitted to download the books, or read any of the books that
have been archived. They would be charged separately if they want to use these additional options not provided in the policy.

In Package option, a specified amount would be collected towards web service usage. The time, content, and functions permitted would be specified as part of the package. Users would be levied additional charges for additional functions not included as part of the package. The price levied for additional functions would vary, depending on the function requested. Users would be charged extra when their web service usage time exceeds the threshold specified in the package. Additional charges would also be levied when the volume of content (bytes of data) accessed exceeds the amount specified in the package. Sample packages are shown in Table 3.3.

<table>
<thead>
<tr>
<th>Option</th>
<th>Package1</th>
<th>Package2</th>
<th>Package3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Read access</td>
<td>Limited 1h per day</td>
<td>Limited 4 books per</td>
<td>Unlimited</td>
</tr>
<tr>
<td>Download</td>
<td>NA</td>
<td>NA</td>
<td>1024MB</td>
</tr>
<tr>
<td>Usage charges</td>
<td>Rs.15/hr</td>
<td>As per charge on book</td>
<td>Rs.400/ for 1024MB</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Rs.15/- for Additional</td>
</tr>
<tr>
<td>Archived books usage charges</td>
<td>NA</td>
<td>Rs.80/Book</td>
<td>Rs.500/ for 1024MB</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Rs.20/- for Additional</td>
</tr>
<tr>
<td>Archived books read&amp;downloa</td>
<td>NA</td>
<td>NA</td>
<td>Rs.600/ for 1024MB</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Rs.25/- for Additional</td>
</tr>
</tbody>
</table>

It can be noted that the packages offer different charging patterns for users: charging on time or volume basis. Some functions may be included in the package while others are charged separately. For example, the
download function is not included in Package1 and Package2 but included in Package3. The charging policy for Package1 is given in Figure 3.7.

```xml
<wsp:Policy xmlns:wsp="http://www.w3.org/ns/ws-policy">
  <E-book>
    <Provider name="Provider1">
      <scheme type="Package">
        <ChargingPolicy>Member</ChargingPolicy>
        <Package1>
          <access_fee>
            <wsp:All>
              <read_perhour>1</read_perhour>
              <Usagecharge_perhour_rupees>15</Usagecharge_perhour_rupees>
            </wsp:All>
          </access_fee>
        </Package1>
      </scheme>
    </Provider1>
  </E-book>
</wsp:Policy>
```

**Figure 3.7 The Charging Policy of E-Book Reading Service “Package1” Pricing Scheme**

It can be noted that in this package, the web service usage is charged on session or connection time basis, which is 15 rupees/hour. The users have limited access to the e-books. They are permitted to read on-line for one hour every day. The users are not permitted to perform any download operation and read/download books from the archival. The charging policy for Package2 is given in Figure 3.8.
In Package2, the users are charged based on the content accessed (volume based charging) and for additional functions used. The users have limited access to currently displayed e-books and are permitted to read 4 books per month. The rate for reading a book is associated with the book, and each book could have different reading charges based on its release date and popularity. However, unlimited access to archived books is provided. All other functions are charged. The charging policy for Package3 is given in Figure 3.9.
<wsp:Policy xmlns:wsp="http://www.w3.org/ns/ws-policy">
  <Provider name="Provider1">
    <scheme type="Package">
      <ChargingPolicy>Member</ChargingPolicy>
      <Package 3>
        <access fee>
          <wsp:All>
            <read_perhour>unlimited</read_perhour>
            <download_perMB>unlimited</download_perMB>
            <download access_MB >1024</download access_MB >
            <usagecharge Download_rupees>400</usagecharge>
            <usagecharge ArchivedBook_rupees>500</usagecharge>
            <usagecharge_read_download ArchivedBook_rupees>600</usagecharge>
            <extracharge_per20MB rupees>15</extracharge>
            <extracharge__ArchivedBook_per20MB rupees>20</extracharge>
            <extracharge_read_download ArchivedBook_per20MB rupees>25</extracharge>
          </wsp:All>
        </access fee>
      </Package 3>
    </scheme type="Package">
  </Provider name="Provider1">
</wsp:Policy>

**Figure 3.9 The Charging Policy of E-Book Reading Service “Package3” Pricing Scheme**

The users of Package3 are being charged on a volume (bytes of data) basis. When the volume of content accessed exceeds the threshold value of 1024 MB specified in the policy, the users would be levied an additional charge of Rs.15/- for each additional 20 MB. The charging is similar for archived books with the rates being different. Charges have been specified for accessing the composite function that permits reading and downloading books.
In Personal charging scheme, the user can develop a package with options of their choice. The charging would be calculated based on the options chosen. An sample personal pricing sample is given in Table 3.4.

**Table 3.4 E-Book Member Personal Pricing Scheme Sample**

<table>
<thead>
<tr>
<th>Option</th>
<th>Personal Pricing Policy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Online Reading</td>
<td>Unlimited</td>
</tr>
<tr>
<td>Download charges</td>
<td>Rs.25 / 20MB</td>
</tr>
<tr>
<td>Special books Usage charges</td>
<td>Rs.30 / special book</td>
</tr>
</tbody>
</table>

```xml
<wsp:Policy xmlns:wsp="http://www.w3.org/ns/ws-policy">
  <E-book>
    <Provider name="Provider2">
      <wsp:Exactlyone>
        <scheme type="Personal">
          <ChargingPolicy>Member</ChargingPolicy>
          <access_fee>
            <wsp:All>
              <read_perhour> unlimited </read_perhour>
              <read_BookperMonth> unlimited </read_BookperMonth>
              <read_special_Book> unlimited </read_special_Book>
              <download_perMB> unlimited </download_perMB>
              <download_SpecialBookperMonth> unlimited </download_SpecialBookperMonth>
              <Usagecharge_per20MB_rupees>25</Usagecharge_per20MB_rupees>
              <Usagecharge_per20MB_rupees>30</Usagecharge_per20MB_rupees>
            </wsp:All>
          </access_fee>
        </scheme>
      </wsp:Exactlyone>
    </Provider2>
  </E-book>
</wsp:Policy>
```

**Figure 3.10 E-Book Charging Policy for Member Personal Pricing Sample**
The user has opted for a Personal package that permits unlimited reading time, while download is charged Rs.25 / 20MB, but with no limit on download. The charging policy for the sample Personal package is shown in Figure 3.10.

The Group charging scheme allows a set of users to form a group and decide on the package of their choice. The charges would be calculated, based on the options chosen, the number of users, and volume of expected transactions. A sample Group pricing policy is shown in Figure 3.11.

```
<wsp:Policy xmlns:wsp="http://www.w3.org/ns/ws-policy">
  <E-book>
    <Provider name="Provider2">
      <scheme type="Group">
        <ChargingPolicy>Member</ChargingPolicy>
        <scheme type="Group">
          <wsp:Exactlyone>
            <wsp:All>
              <Group_size_min>5</Group_size_min>
              <Group_size_max>10</Group_size_max>
            </wsp:All>
          </wsp:Exactlyone>
          <access_fee>
            <wsp:All>
              <read_perhour>unlimited</read_perhour>
              <download_perMB>unlimited</download_perMB>
              <Usagecharge_per20MB_rupees>35</Usagecharge_per20MB_rupees>
            </wsp:All>
          </access_fee>
        </scheme>
      </Provider2>
    </E-book>
  </wsp:Policy>
```

**Figure 3.11 E-book Sample Charging Policy for Group Pricing Scheme**

The charging policy indicates that the group can have a minimum of 5 members and a maximum of 10 members. The details of the users who
form the group would have to be registered with the service provider. The users have unlimited read and download access.

### 3.3.2.2 Non-member pricing policy scheme

Non members are allowed on a pay-per-use basis. Users would be required to pay in advance before using the web services, that is pre-paid basis, to ensure that payment is assured. Here again, the users can be charged based on the web service usage time, or on the basis of the content accessed, as shown in Figure 3.12.

![Figure 3.12 Non-Member Policies](image)

#### Table 3.5 E-Book Non-Member Sample Pricing Scheme

<table>
<thead>
<tr>
<th>Option</th>
<th>Pay per use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Read access</td>
<td>Unlimited</td>
</tr>
<tr>
<td>Download</td>
<td>Unlimited</td>
</tr>
<tr>
<td>Usage charges</td>
<td>Read: Rs.10/hour, Download: Rs.10/MB</td>
</tr>
<tr>
<td>Archived books Usage charges</td>
<td>Rs.65/ book</td>
</tr>
</tbody>
</table>
<wsp:Policy xmlns:wsp="http://www.w3.org/ns/ws-policy">
    <E-book>
        <Provider name="Provider2">
            <wsp:Exactlyone>
                <scheme type="Pay peruse ">
                    <ChargingPolicy>Non-member</ChargingPolicy>
                    <wsp:All>
                        <read_perHour>unlimited</read_perHour>
                        <read_BookperMonth>unlimited
                        </read_BookperMonth>
                        <download_perMB>unlimited</download_perMB>
                        <Usagecharge_perhour_rupees>10
                        </Usagecharge_perhour_rupees>
                        <Usagecharge_perMB_rupees>10
                        </Usagecharge_perMB_rupees>
                        <Usagecharge_perArchivedBook_rupees>65
                        </Usagecharge_perArchivedBook_rupees>
                    </wsp:All>
                </scheme>
            </wsp:Exactlyone>
        </Provider2>
    </E-book>
</wsp:Policy>

**Figure 3.13 The Charging Policy of Pay- per- use Pricing Scheme**

The sample scheme shows that the users are permitted unlimited access to books online and are permitted unlimited download. Reading is charged on session time of Rs.10/hour while download is charged on volume basis of Rs.10 per MB of data downloaded. Rs.65 is charged for accessing each archived book. The charging policy for the sample pricing scheme is given in Figure 3.13.
3.3.3 Charging and Accounting Policy Generation Tool

A tool has been developed to automate the creation of the charging policies in WS-Policy standard format. Service Providers would be required to create a new policy for each web service that is being offered by them. The service details and pricing options would be accepted on screens and the policy in WS-Policy format would be created. A screen snapshot of the policy generation screen which accepts the service provider details is shown in Figure 3.14.

![Accounting For Web Service](image)

Figure 3.14 Service Provider Registration

The above screen is used to accept service provider details which include web service provider name, company name, e-mail id, and contact details etc. A service provider may have more than one web service offering.

Each policy details are accepted as shown in Figure 3.15.
Figure 3.15 Screen Snapshot of Policy Generation Tool

Option has been provided to allow the service provider to view, modify and/or delete their policies. A service provider could have multiple service offerings. Option is provided to copy the policy between services and between service providers. A sample policy generated in WS-Policy standard is shown in Figure. 3.16.
The sample policy shows the different types of policies based on session, based on volume and, based on function of service provider.

### 3.3.4 Charging and Accounting Policy Query

The charging and accounting policies are stored in WS-Policy format. Any standard query package can be used to query the policy details.
The query facility is illustrated using XQuery. XQuery provides a powerful mechanism to access and manipulate the data stored in XML documents (Nambiar et al 2001). A sample policy given in Figure 3.17 is considered to explain the query process and results.

```
<wsp:Policy xmlns:wsp="http://www.w3.org/ns/ws-policy">
  <E-book>
    <wsp:Exactlyone>
      <ChargingPolicy>Member</ChargingPolicy>
      <Provider name="Provider1">
        <scheme type="fixed">
          <Membership_fee>
            <wsp:All>
              <monthly_rupees>100</monthly_rupees>
            </wsp:All>
            <access_fee>
              <wsp:All>
                <monthly_rupees>500</monthly_rupees>
                <bi-monthly_rupees>800</bi-monthly_rupees>
                <quarterly_rupees>1200</quarterly_rupees>
                <half-yearly_rupees>1800</half-yearly_rupees>
                <annual_rupees>3500</annual_rupees>
                <read_perhour>unlimited</read_perhour>
                <read_BookperMonth>unlimited</read_BookperMonth>
              </wsp:All>
            </access_fee>
            <scheme type="Package">
              <Package1>
                <Membership_fee>
                  <wsp:All>
                    <monthly_rupees>100</monthly_rupees>
                  </wsp:All>
                </Membership_fee>
              </Package1>
            </scheme>
          </scheme>
        </Provider>
      </scheme>
    </wsp:Exactlyone>
  </E-book>
</wsp:Policy>
```

Figure 3.17 (Continued)
<read_perHour>1</read_perHour>
<Usagecharge_perhour_rupees>15</Usagecharge_perhour_rupees>
</wsp:All>
</access_fee>
</Package1>
<Package2>
<Membership_fee>
<wsp:All>
<half-yearly_rupees>150</half-yearly_rupees>
</wsp:All>
</Membership_fee>
<access_fee>
<wsp:All>
<read_archived_Book>limited</read_archived_Book>
<read_BookperMonth>4</read_BookperMonth>
<Usagecharge_perBook_rupees>as per charge on book</Usagecharge_perBook_rupees>
<Usagecharge_perArchivedBook_rupees>80</Usagecharge_perArchivedBook_rupees>
</wsp:All>
</access_fee>
</Package2>
<Package 3>
<Membership_fee>
<wsp:All>
<read_perhour>unlimited</read_perhour>
<download_perMB>unlimited</download_perMB>
<download_access_MB>1024</download_access_MB>
<half-yearly_rupees>400</half-yearly_rupees>
<annual_rupees>700</annual_rupees>
</wsp:All>
</Membership_fee>
<access_fee>
<wsp:All>
</Package 3>

Figure 3.17 (Continued)
Figure 3.17 Sample Charging Policy Used to Illustrate Query Facility
The WS-Policy shows the charging policies of two service providers, “Provider1” and “Provider2”. XQuery is a language that is used for finding and extracting elements and attributes from XML documents. It provides flexibility to query XML information sources, and defines human readable syntax for that language. XQuery defines the FLWOR expression, named after its five clauses: for, let, where, order, return that supports iteration and binding of variables to the intermediate results. The query policy is explained with some sample queries.

**Query 1: Providers offering E-Book Reading Service:**

XQuery to obtain the names of service providers offering E-Book Reading Service and the results of the query is shown in Figure 3.18. For and Return clauses have been used to formulate the query.

<table>
<thead>
<tr>
<th>Query</th>
<th>Query Result</th>
</tr>
</thead>
</table>
| For $v$ in //Provider  
Return data($v/@name) | Provider2, Provider1 |

**Figure 3.18 XQuery - Sample Service Provider Query**

**Query 2: Charging Schemes offered by Provider1**

XQuery given in Figure 3.18 shows the query to obtain the names of charging schemes offered by service provider Provider1. For, Order and Return clauses have been used to formulate the query. The result of the query is also shown.
Figure 3.19  XQuery - Sample Query showing Charging Schemes of Provider1

Query 3:  Membership Subscription amount for Package3 offered by Provider1

XQuery given in Figure 3.20 shows the query to obtain the different membership subscription rate offered by service provider1 for the Package3 charging scheme. For, Where and Return clauses have been used to formulate the query. This query returns a string created by concatenating the half-yearly_rupees and annual_rupees. The result of the query is also shown.

Figure 3.20  XQuery - Sample Query showing Membership Subscription Amount of Provider1
It can be seen that the result of XQuery shows the different types of membership subscription amounts offered by service Provider1.

**Query 4: Book Download Charge under Pay-Per-Use scheme offered by Provider2**

XQuery given in Figure 3.21 shows the query for obtaining the book download charge of Provider2 for Pay-per-use scheme. For, Where, Let, and Return clauses have been used to formulate the query. The result of the query is also shown.

```
Query
let $download_perMB:=10
for $u in .//Provider
  where $u/@name="Provider2"
  return
  for $v in .//$u/scheme
    where $v/@type="Pay-per-use"
    return
  for $w in .//$v/access_fee
  return concat("download_perMB for Pay-per-use is ",data($w/Usagecharge_perMB_rupees))
```

**Query Result**
download_perMB_rupees for Pay-per-use is Rs.10

**Figure 3.21** XQuery - Sample Query showing Book Download Charge of Provider2
3.4 CONCLUSION

A generic accounting architecture for web services has been discussed in this chapter. The proposed accounting architecture aims to automate the accounting functions of web services. The design of the other accounting modules is explained in the next chapter.

It is proposed to use policies to specify the different pricing schemes offered by service provider. Business requirements are constantly changing and consequently the service offerings and pricing would also change. Policies offer flexibility to specify and easily update pricing schemes. The WS-Policy standard has been proposed to create and maintain the Charging and Accounting Policies.

A sample E-Book application has been used to explain the use of policies to specify the different charging schemes offered by service providers. A policy generation tool has been developed and explained to facilitate the creation and update of the policies in WS-Policy format. As policies are expressed in WS-Policy, it becomes easy to query and obtain information on the charging schemes. The query facility has been explained using XQuery.