3.1 Overview

The proposed architecture for automatic costing of Web services consist of the basic Web service model components such as Web service provider, Web service consumer and the UDDI registry. The three basic operations of the Web service architecture denoted by publish, bind and find still exist. In addition it has a third party broker based Automated Web service Measuring, Monitoring, and Costing system (AWMMC) which stores QoS information for every customer request into a QoS database. The WSLA provides input to the measurement and management system of an organization that checks and manages an organization's compliance with the WSLA [5].

3.2 Proposed Architecture

The proposed architecture for automatic costing includes the module for the selection of Web services, assertion of QoS, evaluation of actual QoS and cost, reporting the violations and management decisions against the violations of the Web services. Figure 3.1 illustrates the proposed architecture and it implementations.

3.2.1 Assertion of Guarantee

The expected level of performance of a Web service is fixed based on some assertions. Normally, the cost of a service is fixed as per the expected quality which is agreed by the provider and the customer.
Figure 3.1: Architecture of QoS based costing and monitoring
In the proposed architecture, the QoS of the Web service is asserted based on the functionality of the Web service mutually agreed by both the signing parties. Such agreed guarantee values are mentioned in the WSLA document for monitoring of performance of the Web services while usage.

### 3.2.1.1 Selection of a Web service

The service is an abstraction that encapsulates a certain software function. One of the fundamental and distinctive characteristics of services is the separation of interfaces from actual implementation. With the proliferation of SOC the number of available Web services grows. It becomes more and more problematic for clients to discover useful Web services among those available on the Web. One of the main goals of this research is to discover the required Web service based on the desired quality. The most suitable Web service is selected by evaluating the expected QoS by considering the guarantee given by the provider. Web service optimization offers strategies for finding the “best” Web services or their composition with respect to the expected user-supplied quality. Due to the large space of competing Web services, a service request could be potentially resolved by multiple services. Thus, it is necessary for Web service optimization to set an appropriate criterion to select the “best” among possible choices. Recent researches show that, QoS of individual Web services is crucial for their competitiveness. In this proposed work the selection of the service is purely based on analyzing the functionality of the Web service. The functionality is finalized as per the requirement analysis and mainly based on the customer perspective.
3.2.1.2 Assignment of Functional Weights and Assertion of Guarantee

The increasing number of Web service providers has prompted research in service description and discovery. Web service consumers need tools to search for suitable services all over the world. This poses challenges not only in discovery mechanisms but also in guaranteeing high quality information for published services [36]. UDDI supports Web service description and discovery based on the functional aspects. However, consumer requirements may include not only the functional aspects of services but also non-functional properties. Thus, the service discovery depends on the ability to describe and to match QoS offers and demands, in addition to functional capabilities [76] [4] [58] [31]. To evaluate the accurate QoS of the Web service, the functionality based weight fixing method is proposed in this architecture. Apart from the non-functional guarantee by the provider, these weights are also taken care to evaluate the QoS. The domain specific and independent attributes are considered to assign the functional weights to non-functional parameters. These weights are normalized and used with the agreed non-functional guarantee to assert the QoS of the Web service.

3.2.1.3 Implementation of Guarantee into WSLA Document

The guaranteed levels of expectations that are mutually agreed by the signing parties are asserted in the WSLA document. The WSLA language specification [85] [71] is the core of this architecture, and is a XML based language for specifying SLAs related information. It specifies how the electronic contract (SLA) among the service consumer, service provider, and third parties, as well as the way interaction among them can be carried out. The explicit representation of service level objectives and action guarantee provides a very flexible mechanism to define obligations on a case-by-case basis. In this
proposed architecture, the non-functional parametric guarantee and the assigned appropriate weights are mentioned in the corresponding parts of the WSLA document. The asserted values mutually agreed by both signing parties are mentioned in the service level objective part of the WSLA document. Part of the document is shared by the third party broker to check whether the actual metrics measured by the measurement service reaches the expected level of guarantee.

In the WSLA document the assigned weights and asserted guarantee values are mentioned in the following parts:

**Parties**: This part identifies all the contractual parties and their technical properties such as their interface definition. It consists of subpart signatory parties that is used to define the service consumer and provider, and supporting parties that is used to define the third party. In the proposed architecture, the third party broker is responsible for measuring the matrices, evaluating the QoS, checking the guarantee values and reporting to the top management of the service. So, this section contains the information about the signing parties and the supporting parties mutually agreed by signing parties involved in the Web service management activities.

**Service description**: This part of the proposed schema defines various SLA parameters and their measurement or computational procedure for service objects. The service definitions capture the common view of the service that is shared by the contracting parties. This includes references to the service operations and bindings as well as the information needed to define the service level guarantee in the subsequent part of the SLA [57]. The SLA parameters and the corresponding metrics represent the monitored properties of a service object. The parameters such as response time, throughput,
reliability, successibilty, availability used in the evaluation of QoS in this research work are presented. The measurement directive or function subpart information defines how the metrics are measured or computed. The services description information is used by the measurement service to know how to measure and compute aggregate (e.g. mean, median, minimum, maximum of response time) metrics from resource metrics.

**Obligations:** This part of the proposed schema defines the guarantee, and constraints that may be imposed on SLA parameters. The WSLA language provides two type of obligations that is: Service Level Objectives (e.g. mean response time < 2 s), and action guarantee (e.g. if SLO is violated, send notification).

### 3.2.2 Evaluation of QoS at Runtime

Evaluation of QoS is the main part of this architecture that gives the actual performance of the Web service. This architecture proposes a third party broker service that involved in metric instrumentation, measurement of the actual performance, comparing the actual with the guarantee, costing based on performance and reporting the violation to the top managements of the signing parties.

#### 3.2.2.1 Metrics Instrumentation

In this architecture, the instrumentation service and service-using application can be used to obtain the measurements from the customer and provider system to check the actual performance of the service. The values are measured dynamically when the service is invoked by the client [22].
3.2.2.2 Third Party Broker Services

In this architecture, the third party Broker is sponsored by both the signing parties and can perform the following roles:

a. **Measurement service**

A measurement service implements the measurement function requires for both the signatory parties. The measurement functionality receives the measured metrics from the system's instrumentation. Instructions to measure a particular system parameter are defined in the measurement directives of a WSLA [22]. Also the directive depends on the functionality of service that mutually agreed by the signing parties.

b. **Guarantee level check**

This module is responsible to constantly monitor the measured or calculated values of SLA parameters from the measurement service with Service Level Objectives (SLOs), and notifies management service of the contractual parties. Quality of Service could encompass a number of quantitative and qualitative parameters (non-functional properties) that measure the Web service performance in delivering its functionalities. A guarantee level check service implements condition evaluation function that covers all or a part of the guarantee of a WSLA in comparison with the parametric values from the measurement service.

c. **Automatic costing**

The costing service proposed in this architecture is responsible for the calculation of cost as per the offered QoS. The actual parametric values from the measurement function are compared with the guaranteed level to find the QoS performance and actual
cost for usage of the Web service is calculated. The costing is normally done for a specific period of time or based on the number of invocations.

d. Reporting the violation

The reporting module in the third party broker service reports the top management of both the signing parties at the end of each billing period. If there is a violation from the guaranteed level of performance reported by the guarantee level check service, the deviation is recorded in the QoS database and the action is invoked on the management function. The action to be taken in case of any deviation from the guaranteed level is mentioned in the obligation part of the WSLA document.

3.2.3 Management Decision against Violations

A management service implements the management actions of a signatory party. Management implements actions that are invoked upon guarantee violations. The customer can inquire the provider about the violation and force the provider to update the service based on the requirement in the continuing terms of costing. Also, the provider can take immediate action in case of any deviation and failure to meet the asserted service guarantee to maintain his reputation.

The proposed management service is responsible to receive notifications sent by the condition evaluation service, and take appropriate corrective actions on behalf of the managed environment if a SLO is violated. The management service consists of several port types with operations for the exchange of management information (such as: GetMetricValue, ParameterUpdate, GetSLAParameterValue, Notification and StandardMeasurementIF) and can be implemented as a part of an existing systems management platform. The management service is inside the service provider the
consumer management environment. Here the management refers the top management of the parties who bears the financial liability incurred by the service. The management services of both the signing parties get the report from third party broker for further action. The action means the corrective measures should be taken in case of any deviation.

3.3 Summary

In this chapter explained the Automated Web service Measuring, Monitoring, and Costing system (AWMMC) architecture and its modules are explained. To meet the customer requirement, the functionality based weights are fixed for the non-functional parameters of the Web service during its selection. These weights are used with the parametric values to evaluate the QoS of the Web service. The cost of the Web service can be calculated using the actual QoS in comparison with the guaranteed QoS in the WSLA document. The deviation from the asserted performance is forwarded to the management of the customer and provider for further development.