AN IMPROVED STRATEGY TO SUPPORT MULTIPLE QoS ASSESSMENT FOR SELECTING CONTENT ADAPTATION SERVICES

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ABSTRACT

Content adaptation is a solution in providing ubiquitous access of the increasingly rich Internet multimedia contents (i.e., resources) to a variety of usersô requirement, along with their limited deviceôs capability (i.e., delivery contexts). Service Oriented Content Adaptation (SOCA) framework enables users to use content adaptation services on pay-as-you-go basis, thus demanding for a good quality of service (QoS). One of the important QoS criteria is the maximum time that a user can wait (i.e., response time) for the output to be displayed. The service provider offers one waiting time (QoS) during the advertisement, based on the fair load. However, the advertised waiting time may not be deliverable accordingly during the actual service execution due to a heavy load. Practically, the service provider should be able to estimate a current deliverable response time before the Service Level Agreement (SLA) settled. With the purpose of overcoming these constraints, this thesis will be focusing on providing an improved strategy, called one-to-multiple assessment strategy for SOCA framework, that focuses on assessing current waiting time and evaluate its deliverability. The purpose of SLA assessor is to consider the current QoS (server load) of other services negotiated for the other interrelated tasks. This is performed by a function called a checker. In conclusion, the SLA assessor improves the SLA settlement rate between users and content adaptation services. Also, it reduces the extra overhead (i.e., communication step) to reconsidering another service for a particular task compared to the existing one-to-one assessment strategy.

ABSTRAK

Penyesuaian kandungan merupakan penyelesaian di dalam menyediakan akses di mana-mana sahaja pada kandungan Internet multimedia (iaitu, sumber) yang semakin banyak untuk pelbagai keperluan pengguna, bersama-sama dengan keupayaan peranti terhad mereka (iaitu, konteks penghantaran). Rangka kerja Perkhidmatan berorientasikan penyesuaian kandungan (SOCA) membolehkan pengguna untuk menggunakan perkhidmatan penyesuaian kandungan secara pengguna bayar dan pergi, sekali gus menuntut untuk kualiti perkhidmatan (QoS) yang baik. Salah satu faktor yang dipertimbangkan oleh penyesuaian QoS adalah penggunaan masa maksimum yang boleh ditunggu untuk output dipaparkan. Pembekal perkhidmatan ditawarkan satu masa menunggu (QoS) semasa penawaran dilakukan, berdasarkan kepada bebanan yang rendah. Walau bagaimanapun, masa maklum balas yang ditawarkan tidak dapat dihantar dengan sewajarnya semasa pelaksanaan perkhidmatan sebenar disebabkan bebanan yang tinggi. Di dalam amalan, pembekal perkhidmatan perlu boleh menentukan masa maklum balas boleh dihantar sebelum perjanjian tahap perkhidmatan (SLA) diselesaikan. Dengan tujuan untuk mengatasi kekangan ini, tesis ini menumpukan kepada menyediakan satu strategi yang lebih baik dipanggil Satu kepada Pelbagai penilaian strategi untuk rangka kerja SOCA dengan memfokuskan kepada menaksir waktu menunggu semasa dan menilai keboleh penghantarannya. Tujuan penilai SLA ialah mampu untuk menganggap QoS semasa (pelayan beban) dengan perkhidmatan yang lain berunding untuk tugas lain-lain yang berkaitan. Ini dilakukan oleh fungsi yang dipanggil checker. Kesimpulannya, penilai SLA meningkatkan kadar penyelesaian SLA antara pengguna dan perkhidmatan penyesuaian kandungan. Selain itu, ia mengurangkan overhed tambahan (iaitu, langkah komunikasi) untuk menimbang semula perkhidmatan lain untuk tugas tertentu berbanding dengan strategi satu kepada satu penilaian yang sedia ada.

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1 Mohamed, J., Fudzee, M. F. M, & Ismail, M. A. (2014). Incorporating Human Psychological Factor in Assessing the Deliverability of Quality of Service (QoS) for Multimedia Content Adaptation Services. In *Knowledge Management International Conference, Langkawi, Malaysia*. ISI Indexed

2 Fudzee, M. F. M., Mohamed, J., Abawajy, J., Kasim, S., & Ismail, M. N. (2014). An SLA Evaluator for Multimedia Content Adaptation Services. In *Information Science and Applications (ICISA), 2014 International Conference on* (pp. 1-4). Scopus Indexed

3 An SLA based framework for evaluating QoS for selecting content adaptation services. Accepted to MUCET 2015 publication.

CHAPTER 1

INTRODUCTION

1.1 Introduction

In recent years, mobile documents has been revolutionized with the variety of uploading and downloading methods since the grandeur of current browser technology. The impact of the upcoming technology can influence the quality of service that should be acknowledged by the end users. Some of the mobile technology, including the advanced wireless technology and ubiquitous Internet access that is high in quality. As the heterogeneity of mobile devices such as smart phones and tabs grows, surfing and browsing websites through mobile devices has also become very popular. The recent trend is the content adaptations that are notoriously demanded, and has become profitable mobile contents of its quality to the Internet as one of the third party services (Arai & Tolle, 2010).

Content adaptation is particularly used to bridge the disproportionate the resources by providing users with contents that is appropriate to the given contexts, e.g., device capability or network bandwidth. Content adaptation in multimedia is termed as the process of transforming a logical set of multimedia elements, from a source of representation (by service provider) to one or more target representations (user) (Gibbon, 2008; Knight & Angelides, 2008; Alaa *et al.,* 2013). It is not only accommodated a restricted device input and output capabilities, but it also supports the content delivery over bandwidth constrained connections such as wireless links (Zhou *et al.,* 2014). This process enables the existing content adaptation system to approach such as client-side and server-side. These content adaptation systems,

sometimes, encounter limited adjustment functionality, get overload when too many users connected, and even may lead to failure. Thus, it will cut the limitation of information of the services (Yang & Shao, 2007).

In utilizing the World Wide Web environment, the concept of óestablishing a content adaptation as a service that allows the use of a huge number of adapted content located in many places in the networkô has recently been advocated. Nowadays, there are many service providers offer a variety of content adaptation that can be loosely coupled. Therefore, the solution for these services is to cooperate with each other through service composition to completely serve the request that they cannot attain individually.

Service-oriented Content Adaptation (SOCA) is formed based from the service oriented architecture (SOA) (Tsai *et al.,* 2010). SOCA presents a model that enables the content adaptation to be consumed as Web services (Fudzee & Abawajy, 2011b). However, current solutions, according to Alhamad *et al.,* (2010), do not take into account the human psychology factor in negotiating with services. One of these factors is of how long that user can wait for the output to be displayed. In addition, response time is a óde factoô of the quality of service (QoS), and it should be highly considered in accessing the content adaptation service delivery.

Specifically, previous researches have shown that usersô frustration increases when a page load time exceeds 8 to 10 seconds, without getting any feedback (Szameitat *et al.,* 2009). Willingness to wait is further determined by other factors such as types of connections, users' characteristics, the importance of tasks, and frequency of visits (Kohrs *et al.,* 2014; Thomaschke *et al.,* 2014). For example, the usability of information systems by users experienced respondents has stated that due to an inadequate user-interface were wasting their time (77.36%), frustration or stress (61.64%), loss of data (42.14%), low productivity (26.42%) and financial losses (7.55%) (Cioca *et al.,* 2014; Pocatilu *et al.,* 2015). According to this statement, wasting time is the most negative repercussions to the user experience respondents. It is clearly shown that respondents were not satisfied with the response time of delivering the information (Arapakis *et al.,* 2014). The response time is an important aspect of the perceptual users (Weber *et al.,* 2013; Thomaschke *et al.,* 2014). User can quit their activity, and the delays will cause some discontentment, stress, and the performance will decrease (Lobo *et al.*, 2011; Wo3niak *et al.,* 2011;

Egger *et al.*, 2012). Due to this matter, we have decided to address this problem by taking into account userôs waiting time factor for content adaptation services.

1.2 Problem Statement

Service Oriented Content Adaptation (SOCA) framework enables the adapted content to be delivered to a number of services based on the advertised QoS. Users are willing to pay for the service, thus leads to demanded for good service quality. One of the factors considered by the QoS adaptation is the maximum time that user can wait for the output to be displayed. In addition, response time is an important issue to be considered in assessing the deliverability of content adaptation services.

Existing solution presents a single evaluation of Service Level Agreement (SLA). An example of an important QoS is waiting time. The service provider offers one waiting time QoS during the advertisement, based on the fair load. However, the advertised response time may not be deliverable accordingly during the actual service execution due to a heavy load. Practically, the service provider should be able to estimate a current deliverable response time before the SLA settled.

Previously, existing negotiation strategy presented in Fudzee (2011) comes with an existing one-to-one negotiation strategy that is managed by client-side quality valuation, which gives advises during the service selection process. The service provider offers one waiting time of QoS during the advertisement by assuming fair load activity. However, the advertised response time cannot be delivered accordingly during the actual service execution due to heavy load. This solution does not take into account the total accumulated waiting time of all interrelated services. It only performs single negotiation without considering current QoS negotiation of the services for the interrelated tasks of the same userôs request. Practically, the service provider should be able to determine a current deliverable response time before the SLA is settled with the users.

1.3 Research Question

This research addresses two key issues; (1) *how to enable the quality assurance in term of service level agreement* (SLA model); and (2) *how to enable the negotiation of quality of service* (QoS negotiation) for content adaptation services, by taking into account the acceptable waiting time for adapting content based on human psychology.

To enable the quality assurance, a framework is used to manage the service agreement between users and service providers. Hence, SOCA has enabled an adapted content to deliver a number of services based on QoS, a service composition known as a practical solution. A mechanism, that enables the delivery of these interconnected content adaptation services that conform the agreed QoS, is indeed required. However, most of the current frameworks (Alhamad *et al.,* 2010) do not take into account userôs waiting time factor in negotiating with services.

To enable the negotiation of QoS for content adaptation services, a mechanism to negotiate QoS should be considered before the agreement being settled. Previously, the existing solution provides a single evaluation of SLA (Fudzee, 2011). This existing negotiation strategy is developed based on queuing theory to show the relationship between a service provider and server requests. This strategy includes the SLA evaluator to estimate the new waiting time that is potentially being rejected. Basically, the service provider offers one waiting time QoS during the advertise process. By default, a fair load is assumed to be estimated to this offer (Fudzee & Abawajy, 2011c). However, if the server experiences a heavy load, it may not be able to accept all of the incoming requests within the offered waiting time. Due to this problem, the service providers should ensure that the advertised QoS is deliverable to avoid any potential violation.

1.4 Objectives

The objective of this study is to establish the basis for managing the content adaptation servicesô QoSs through the authorization of SLA. Specifically, we plan:

(a) to identify how SLA can be used in SOCA framework by utilizing an SLA model in relation to content adaptation services.
(b) to propose an appropriate strategy to evaluate the quality of services (QoS) by taking into account userôs waiting time.
(c) to simulate and analyze the proposed SLA model in terms of SLA acceptance and request rejection within the simulated environment.

1.5 Scope of Study

There are many content adaptation approaches introduced by previous researchers. They had discovered many parts in content adaptation in terms of SLA. However, current solutions, according to Alhamad *et al.,* (2010), do not take into account human psychological factor in negotiating with the services. One of these factors is of how long a user can wait for the output to be displayed. The main factor to be discussed on to this study is the response time of QoS, and it should be highly considered in accessing the content adaptation service delivery.

Previously, there was an existed research complementing the SLA layers of SOCA, presented by Fudzee (2011). These layers included five interrelated of client, broker, middle layer, server, and provider (Fudzee, 2011). Basically, this architecture demonstrated the flow of the services that were being delivered in sequential. Unfortunately, the previous study had discovered that the service provider offers only one waiting time QoS during the advertise process (Fudzee & Abawajy, 2011c). In addition, if the server experiences a heavy load, it may not be able to accept all of the incoming requests within the offered waiting time.

In providing efficient work to the clients, this study will be discussing on the improvement of the server experiencing a heavy load during advertisement. This study will perform the improvement on the existed study by providing several tasks

in doing the job. From here, the analysis will cover the acceptance rate, the rejection rate, and the communication step for several tasks. The study will conduct more approaches on how to determine the quality of service (QoS) thru SLA by presenting the proposed one to multiple negotiation strategy. The cumulative data will be used in one to many negotiation strategies by innovating the SLA assessor.

1.6 Research Methodology

In this research, the methodology used are ñproof-of-conceptò and ñproof-of-performanceò that includes data acquisition, solution modeling and validation, and implementation and analysis stages. This methodology used due to the experimental computer science method in Snyder *et al.* (1994).

In proof-of-concept, the research study will be gathered by critically reviewed to provide the overview that leads to the formulation of valid problem statements. Then, the data set will be gathered from a reliable server. Next, this data will be validated by the proposed model and an algorithm.

In proof-of-performance concept, the implementation of the algorithm will be executed. From here, the analysis will be processed to obtain a valid result. A detailed explanation of the methodology will be presented in Chapter 3.

1.7 Structure of Thesis

This thesis will be divided into six chapters. Chapter 1 describes the problem statement, objectives, literature review, research methodology and expected finding of the research study. Chapter 2 focuses on the previous studies related to the content adaptation, SLA in content adaptation and SLA in other fields. This chapter will also review other studies about SLA strategies in content adaptation systems as well as the selection of algorithm used by previous researchers. Chapter 3 will be discussing on the research methodology of the study. This chapter presents the system architectures, the methodology used and also the data analysis will be used. Chapter

4 comes up with the design and analysis of the study. Chapter 5 will discuss the results of this study while the last chapter, that is chapter 6, will conclude this study.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Mobile documents are increasing from the aspect of content, and varied in structure and format. At the same time, userôs priority varies towards the contents, and their devices are getting increasingly varied in its capabilities. The disproportionate between rich contents and userôs requirement, along with their deviceôs capability, presents a challenge in providing ubiquitous access to these contents. Nowadays, people prefer to use mobile devices (e.g., smartphones, tablets and etc.) rather than desktop devices (e.g., laptops and desktops). By the increasing variety of platforms and applications, peoples can surf the internet anytime and anywhere. Peoples demanding the ubiquitous computing to get unlimited information and access.

Content adaptation is a potential solution for web content, delivered to the user through heterogeneous devices when arising the acceptable result. In establishing the content adaptation as a service to allow using huge number, the idea of adapting the content located in several places in a network should be supported. There are several service providers that offer a variety of content adaptation services. Each of the service providers advertises their own QoS to represent their information to the clients.

In this chapter, the study will cover along a literature review related to content adaptation systems and the SLA in content adaptation services, as well as the negotiation model.

2.2 Content Adaptation Systems

Content adaptation is used to adapt the content to the given contexts required by the user (Adzic *et al.,* 2011; Chen *et al.,* 2012). Content adaptation usually related to mobile devices that includes selecting, generating and modification process of multimedia content (text, images, audio and video) in adapting to the human-computer interaction to the environment and context utilization (Das, 2010; Lee *et al.,* 2014). The modification process can be applied to transform the content within the same media types (e.g. compressing the image size), and across different media types (e.g. converting pronunciation to a text or from the video element to image montage) (Zhao & Jin, 2011). This process enables the existence of the content adaptation systems such as client-side and server-side. This content adaptation system sometimes encounters limited adjustment functionality, overloads when too many users are included, and it may lead to failure. Consequently, it will cut the limitation of information of the services (Yang & Shao, 2007).

The information transforms into three layers of nature for the content. Figure 2.1 illustrates the concepts of components (Adzic *et al.,* 2011). Basically, all web page contents will include the three elements; text, images and videos. A text can further be grouped by two; font and spacing. The images can be divided into two; size and colors. As for videos, it includes two of audio and frames.

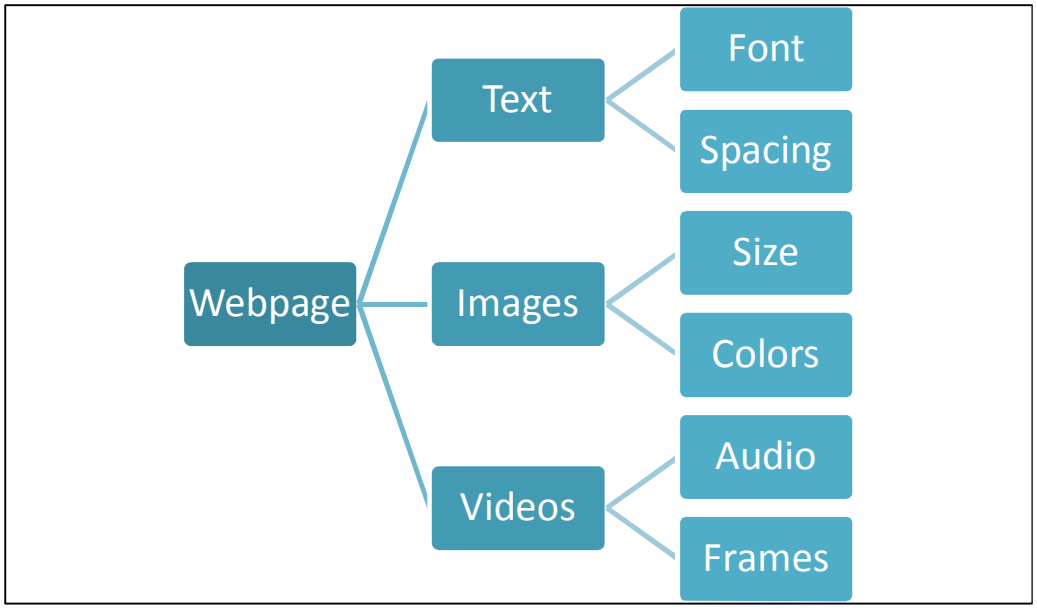

Figure 2.1: Multimedia content components

The element of the text includes the font that usually related to typography. The typography contains the styles of fonts, types of fonts, and its sizes. Each text includes the spacing in order to be meaningful for each paragraph. Spacing helps a website to be readable and efficient in every text. In images element, a size difference may influence every picture and icon. The size contains vector and bitmap that usually influence the quality of images. An image will be meaningful for viewers when colors are added to the images. The pixel of the image will be influenced for every color added. A web page can be attractive to the users when colors are used to emphasize each area. Another important element in multimedia is video. Without utilizing a video, a web page can be dull. The video contains audio that works with sound and visual component. Video is a series of frames that contains lots of pictures and sound and it is played back at a fast rate. It comes from a single frame with a picture of specific actions. When the sequential pictures are grouped together and played back, the picture will give some movements of impressions.

Mobile devices have become popular nowadays, especially with the teenagers. While some of the new applications were invented to suit the mobile devices, usersô behavior are also changed (Maurer *et al.,* 2010). Some of these new applications exploit text, audio, video, graphic and animation elements in gaining and enticing usersô attention (Kosinski *et al.,* 2013; Ahmad & Hong, 2012). The structure of the applications contains different view of content and format (Hsiao *et al.*, 2008; Nimmagadda *et al.,* 2010). There are several issues that are related to the lack of information gathered which need to be overcame in order to provide a ubiquitous access to the content. The issues include the experience of users (e.g., knowledge using the mobile phone), the network provider (e.g., wifi, broadband, data packet) and the capability of device (e.g., the speed performances, operating system) (Lee *et al.,* 2014; Joselli *et al.,* 2012).

2.3 Service Level Agreement in Content Adaptation

In recent years, Service Level Agreement (SLA) has been investigating methods to reduce problems between users and service provider. SLA guarantees that both of them shall understand and work with each other in giving the best services for a good delivery web service. These should be measured based on several factors. The management of SLA replicates the real-time situation, like handling much information that are usually requested by clients. These are some main issues highlighted by SLA management. The issues to be discussed in this study are the definition of SLA, and the QoS in content adaptation.

SLA is defined as the ability of a provider to deliver the information and expectation from clients; the result should be shown together with the measurement and reporting mechanism (Leopoldi, 2002). Wu & Buyya (2011) and Cuomo *et al.,* (2013) mentioned that SLA is a formal agreement between service providers and the customers to guarantee that the quality of service can be achieved by customers. Meanwhile, Kandukuri *et al.,* (2009) stated that the SLA should monitor the information on the services, meaning that the information should be accurate, and contains detailed specifications of exactly what is being delivered.

SLA is implemented effectively through the existence of QoS adaptation and context diversity. The QoS adaptation plays an important role for service providers in selecting the QoS adaptation approach (Sun *et al.,* 2011). Service provider always offers low waiting time, high reliability and availability for users to successfully operate the services (Liu *et al.,* 2010; Bala & Chana, 2011). Kuyoro Shade *et al.,* (2012) emphasized that QoS adaptation is a set of nonfunctional attributes that may impact the quality of the service offered by a service. The set of nonfunctional attributes for QoS adaptation refers to response time, availability, price, reputation and data quality (Alaa *et al.,* 2013; Filieri *et al.,* 2012). This study covers along the QoS adaptation by taking into account the waiting time factor. Before the agreement between users and provider being enclosed, the QoS needs to be negotiated based on the specific adaptation requirements determined by the users.

A context is classified as any information that can be used to characterize the situation of any entity. The user and the application themselves are the example of such entities (Ko *et al.,* 2015; Arachchi & Dogan, 2013). This includes any

information that can characterize an entityôs situation or state. The purpose of the context is to adapt the content to the entity. The context diversity could be a device, network, user or client or combination of them.

2.3.1 Service-oriented Content Adaptation Architectures

Every content adaptation system has different components of its system architecture. The architecture of content adaptation provides an important knowledge before making any choices and decisions upon the existing content adaptation systems. There are five main layers of function that play roles in the systems. Figure 2.2 demonstrates the five layers of content adaptation systems introduced by Fudzee (2011).

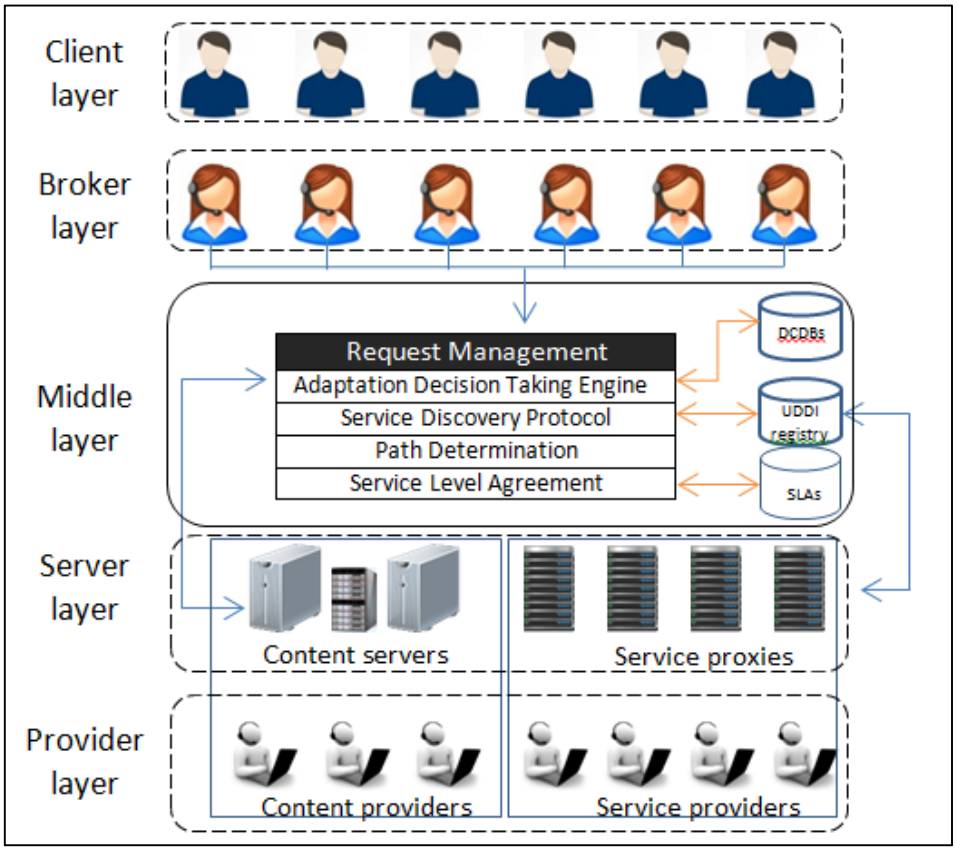

Figure 2.2: Service-oriented content adaptation framework

The Service-Oriented Content Adaptation framework (SOCA) is based on the Service Oriented Architecture (SOA). The system distributes the system architecture

which has been characterized by the logical view of an actual entity, message oriented with service description, and platform neutral. The purpose of the SOCA framework is to give out user expectation by offering added value content, and also to provide flexible and scalable service-based content delivery mechanism (Fudzee, 2011). The five layers of the SLA architecture include; client layer, broker layer, middle layer, server layer and provider layer. The framework is made of components that provide access to content servers, develop user requests to source format, and to manage and provide content description (Fudzee *et al.,* 2010; Garg *et al.,* 2013). In this situation, a client has made a request using the heterogeneous devices (e.g., smartphones and tablets). The service provider is responsible in receiving the information that stores the content, and later to distribute it through the Internet. There are several service providers located in many places in the network that provide a variety of content adaptation services.

Both of the client and broker layer will inspect methods used by the broker in handling the requests from clients. The content adaptation requirements need to be analysed by the broker using Adaptation Decision Taking Engine (ADTE). Another mechanism, known as Device Capability Database (DCDB) stores the device profile that contains the specific information of the device to accurately render the output page of display at the clientôs devices. HTTP protocol is used to get the incoming client request from the broker. The requesting device will later be identified in DCDB by the user-agent header. The capabilities of all devices are retrieved from the database to the identified device. World Wide Web Consortium (W3C) introduces the composite capabilities or preference profile specification that is represented from the clientôs device capability. This device should be activated, and it will be detected through Bluetooth configuration. DCDB should be synchronized regularly, and placed on distributed location. Users may have their own preference in choosing the version of the content. Hence, the broker should identify and analyse the explicitness of this preference.

At the middle layer, there are four interrelated components such as ADTE, Service Discovery Protocol, Path Determination, and Service Level Agreement. ADTE will analyse the content adaptation requirements, and later produce the required task. As for the Service Discovery Protocol, it will search for the potential service from the accessible registry that is capable in performing the tasks. The next component, known as the Path Determination component, will choose the best

service suited for each task by using the QoS criteria. The broker, later, will be dealing with the provider in handling the selected services. The SLA then is settled when the provider agrees to serve the request according to the advertised QoS, otherwise the QoS may or will be negotiated.

A platform is installed at the server, and it will, in this layer, help in providing the content and its adaptation services. Clients will be provided with a content version for the service. The web content consists of content of the server. UDDI registry will be published, and will update the service provider. The service registry will maintain the description that includes service provider, adaptation function types with typical formats, available bandwidth, availability status, cost and time adapted.

2.3.2 Service Level Agreement in other fields

Service Level Agreement is also being explored in other fields of study. The purpose of the inspection is to compare and elaborate the other strategy in improving the cloud computing technology in SLA. In this area, Wu & Buyya (2011) and Cuomo *et al.,* (2013) have investigated the SLA architecture, which is described using a typical utility computing system based on the layered architecture in Figure 2.3. There are four possible layers in this framework. The first layer contains a User or Broker, whom will submit their requests by using various applications to the utility computing system. The second layer contains Service Request Examiner which is responsible for admission control. In the third layer, SLA Management balances workloads, and a Resource or Service Provider offers resources or services. Users or Brokers, who are acting on behalf of the as users, will send their requests and applications, from their devices, to be processed by the utility computing systems.

Before deciding whether to accept or reject the services, QoS requirement will be interpreted, when a requested service is sent by the Service Request Examiner, using an Admission Control mechanism in ensuring that there is no overloading or overlapping of resources that can cause many service requests cannot be successfully fulfilled due to limited availability of services. After fulfilling all of

the required steps, the continue stage, which is at layer four, will start playing their roles. In this layer, the service provider will process the information and give the best resource or service back to the User or Broker-on-behalf.

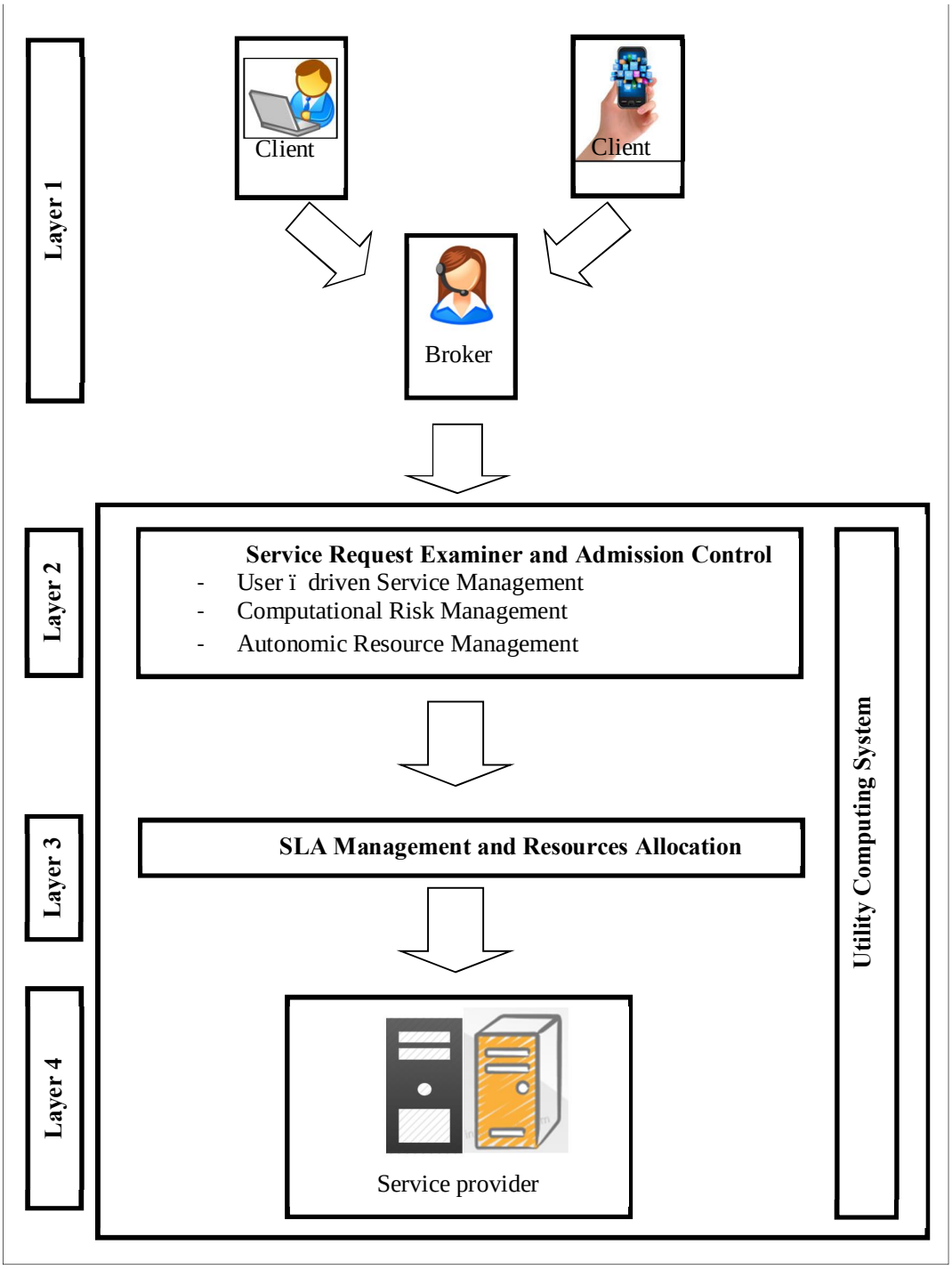

Figure 2.3: SLA Typical Utility Computing System Architecture

2.4 SLA Strategies in Content adaptation system

Content adaptation has already gained considerable importance in today's multimedia communications, and will certainly become an essential functionality of any service, application or system in the near future. The continuity of the advancement in technology will only emphasize the great heterogeneity that exists in current modern devices, systems, services and applications. Likewise, this will also bring out the desires of consumers for more choices, better quality, and more personalization options (Carreras *et al.,* 2009). Typically, content adaptation will include several strategies, as illustrated in Figure 2.4. These strategies will adopt the component of the content, especially from the heterogeneity of mobile devices.

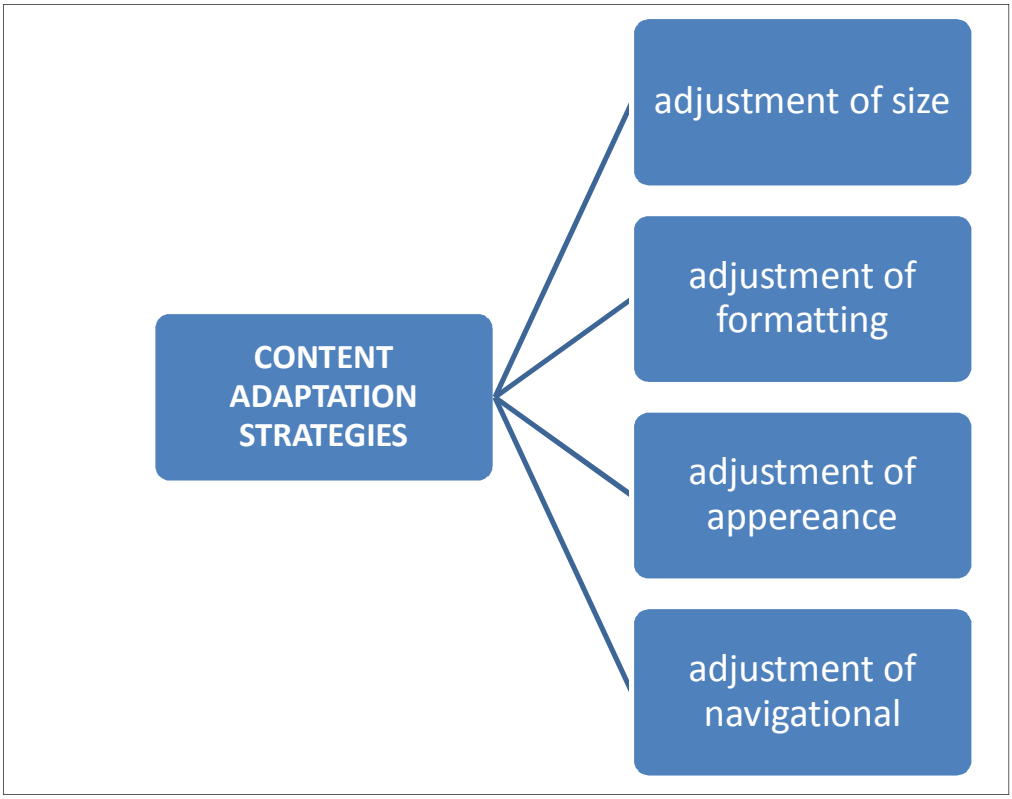

Figure 2.4: Content Adaptation Strategies

Web-based usually will include some images and videos to support their content so that it can appeal to the users. Normally, an image size can viewed to the desktop area. This will give a constraint to the mobile display due to the actual size

of the images. The size adaptation can be adjusted by scaling and resizing the images.

Different mode of media represents different view of formats. An image can be displayed in different formats (e.g., PNG, JPEG, GIF) and in different color scheme (e.g., grayscale, 16-bits color). The adjustment of formatting can be performed by transforming the mismatch content into the appropriate format in the same media. For instance, the application of Whatsapp versus the network. Nowadays, many users own a high quality of camera on their smartphone. Users often send or upload their picture via this application. Some of the users upload the image using the mode of data transfer (e.g., mobile data, wifi). If some of them are using mobile data, the transmitting process may consume several minutes.

The adjustment of appearance deals with the web layout while preserving the content and functionality. Some of the web pages are designed with a fixed width and centered column where the main text resides. In order to overcome this, a multi column web is altered into a single column while surfing with mobile devices.

The content provides the user a tailored content by keywords rather than the whole content segment. The adjustment of navigation provides users with some guidance on how to access the content based on their knowledge and interest. After clicking the keyword, it will navigate the user to their desired content.

Sometimes, users are frustrated when page loading process exceeds over 7 to 10 seconds without getting any feedback (Szameitat *et al.,* 2009). The type of connections, userôs characteristics, and the importance of tasks are some of the factors of usersô willingness to wait for any result (Kohrs *et al.,* 2014; Thomaschke *et al.,* 2014). In the client-side approach, adaptation is demanded to the clientôs device itself, particularly when the adaptation is performed by the Web browser. Server-based approaches, initially, consist of adding content adaptation services to traditional Web server functionalities. Multimedia content transformation is usually generated off-line at the content creation time, often involving a human designer to hand-tailor the content to the specific requirements of few classes of devices (Malandrino *et al.,* 2010).

Server-side monitoring is usually accurate, but it requires the access to the actual service implementation which is not always possible. In contrast, client-side monitoring is independent from the service implementation, but the measured values might not always be up-to-date since this client-side monitoring is usually done by

sending probe requests (i.e., test requests that are similar to real requests). Combining these two approaches will be very helpful in achieving the SLA needs effectively (Michlmayr *et al.,* 2009).

Fudzee & Abawajy (2011c) have proposed a negotiation strategy by allowing a single broker to a single service provider modeled as an M/G/I queue. The model is developed based on queuing theory to show the relationship between a service received by the provider, and the manner the request is served. Figure 2.5 shows the flow of this model.

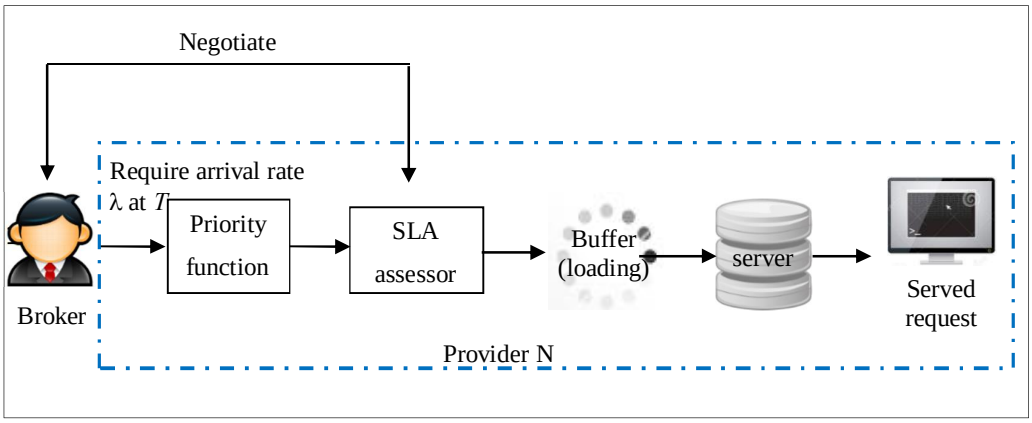

Figure 2.5: QoS Negotiation Model

From the figure, the waiting time is used to reflect the response time. The broker reaches the requested service by searching through the priority function. The current server load will be checked by SLA assessor, and it will estimate the number of requests that can be served within the offered waiting time. The SLA assessor will negotiate between one to one parties. Starting from the broker as on behalf of the user, they reach the requested service by searching the priority function. From there, the SLA assessor will process the loading time that broker should be considered to wait, for example three seconds. Later, if the loading time declares the desirable time by the user, it will focus to the server to process the output data, and the served requested will hire the information result (Raimondi *et al.,* 2008).

2.5 Negotiation Strategy

SLA has raised many issues in several aspects, especially in Web services. Due to this matter, many researchers have come out with lots of ideas, and have addressed the issues to inquire the problem regarding the QoS, and the negotiation of web services provided. In recent work, Elgazzar *et al.,* (2011) has proposed the Web service discovery framework. The idea of the framework has gained lots of advantage in offering better services in a mobile environment. We can figure out the problems that are recently raised by producing a framework, especially when it can be implemented both from service providers and end user. Elgazzar *et al.,* (2013) and Arango (2013) also agreed that this framework helps to perform mobile applications as a service of context-aware platform. Moreover, Goh *et al.,* (2011) has proposed the same issue regarding the mobile device in reducing encumber of user navigation in the huge number of media content by allowing context-aware personal content adaptation and efficient metadata processing.

Aijaz *et al.,* (2010) has planned to enhance the quality of service introduced by SLA, focusing on a framework to offer, the negotiations of SLA, and managing the QoS of the provisioned mobile web services. Aijaz *et al.,* (2010) claimed that there are four primary architectural components, and have classified their functions into four fundamental of SLA life cycles. These methods are similar with Badidi (2011). They proposed a novel framework for Web service provisioning, which relies on brokered SLA, between clients and service providers, and a publish model to handle notifications on essential changes in QoS offerings. Meanwhile, Fudzee (2011) claimed that the negotiation model by focusing on waiting time as QoS adapted to the services. So through this approach, service providers can provide several typed and level of services. In addition, the proposed model allows service brokers to be aware of its essential changes in the QoS offerings of service providers, and able to monitor the execution of SLA (Balakrishnan & Somasundaram, 2011).

On the other hand, Michlmayr *et al.* (2009) has presented a framework that merges the benefits to client-side and the server-side that are monitored by QoS. The framework was developed upon the event processing to inform interested subscribers of current QoS values and possible violations of SLA (Leitner *et al.,* 2010a; Leitner *et al.,* 2010b; Leitner *et al.,* 2013). Petrova-Antonova (2010) have their own opinion

that the QoS separates the web services by the quality of the service on functional and non-functional web service. They allow clients to know the quality of the offered web services by selecting an optimal correlation between quality and price which client should pay for. This method has been followed by Sha *et al.,* (2013) which presents an architecture by focusing on to the cost dependence by userôs satisfactions. This method will report the performance of the web service separately. Besides that, Nurika *et al.,* (2014) and Aziz (2014) have proposed a consumer oriented framework by developing a performance based on simultaneous service level negotiations. This framework offers the maximum price or minimum resource consumption to users, especially for new user who clueless in cloud web service. This framework will facilitate the multiple SLA negotiations (Mukhopadhyay *et al.,* 2013).

Recently, Zheng & Lyu (2013) and Li *et al.,* (2014) have implemented a great strategy to manage the QoS effectively by proposing Basic Fault Tolerance strategy. The strategy called Dynamic Parallel strategy, is the combination of an *n-Version Programming (NVP)* (Avizienis, 1995) and *Active* (Salatge & Fabre, 2007) strategies, to purposely improved the QoS especially the quality in providing the services through user perceptions. Sim (2010) and Venticinque *et al.,* (2011) have discovered the complex Cloud negotiation mechanism designed to support complex negotiation activities in interrelated markets in which the negotiation outcomes between broker and provider agents in a Cloud resource market can potentially influence the negotiation outcomes of broker and consumer agents in a Cloud service market (Son & Sim, 2012).

However, none of these strategies is directly suitable to handle a content adaptation request that usually requires many interrelated tasks. Practically, a number of services are required to give a service requested by the user with one or more tasks. By this required service can be performed by the multiple providers. The path determination differently leads a possible of providersô composition. Figure 2.6 illustrates the example of content adaptation requests from Fudzee (2011).

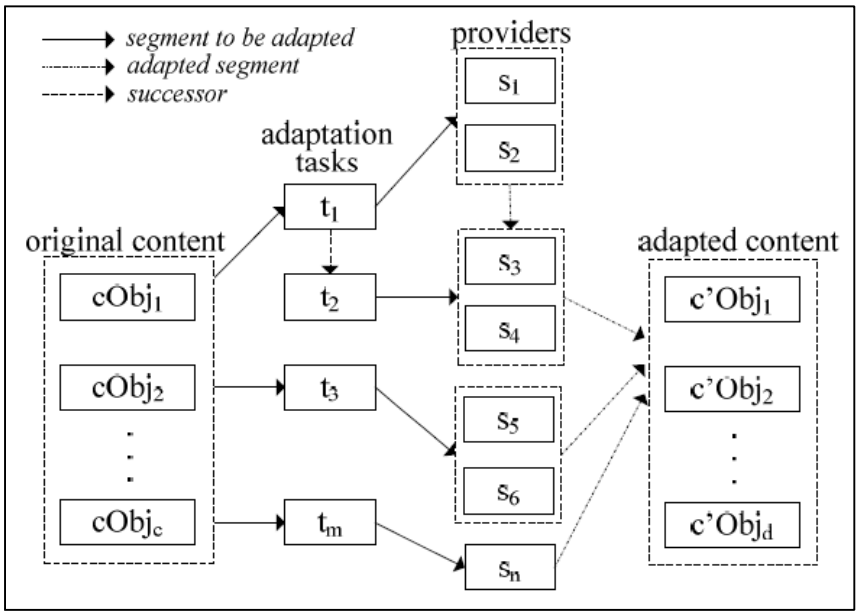

Figure 2.6: example of content adaptation request

Assume that a situation of browsing a certain topic from Internet. This topic will return a heterogeneous result with unstructured text, the data source of web that is deeper, web services, images and other multimedia resources. In this case, a content object may require one or more content adaptation tasks that can be simplified by a few of service providers (Fudzee, 2011).

In improvising the research study, we have viewed some of the potential strategies by providing several tasks to do the job are being evaluated simultaneously instead of single task in the existed research done by Fudzee (2011). The study will be discussing on how to determine the quality of service (QoS) thru SLA by presenting the proposed one to multiple negotiation strategy. The cumulative data will be used in one to many negotiation strategies by innovating the SLA assessor.

2.6 SLA Assessor Algorithm

SLA has been analyzed to enhance the performance of the services. Currently, SLA allows service providers to offer the service, with any kinds of techniques and proposed idea, to successfully deliver the service given to the client. To ensure that

the service provider has given the best services, there are few steps available that allow the services get to the end user. The steps are classified as an algorithm.

The proposed algorithm is focusing on SLA assessor from the proposed framework model for the improvement of the settlement rate of waiting time factor, considered by QoS adaptation. Fudzee *et al.,* (2014) has suggested a single negotiation algorithm at SLA as an evaluator by considering waiting time factor. For the enhancement of this strategy, we will propose a negotiation for multiple task strategy by presenting an SLA assessor algorithm at the broker side. This algorithm enables to receive multiple requests if the actual time exceeded the offer time. This step will be conducted by a checker. The similarity between these two strategies is that both are focusing on the QoS provision multimedia content adaptation (Luo & Shyu, 2011). Meanwhile, Ļoviĺ *et al.,* (2012) has discovered the Mobile Detection Algorithm Based on Tera-Wurfl (MDABTW) as an approach, suitable for the heterogeneousness of mobile devices to encounter the content of such web sites. This approach allows all of the handheld devices for accessing all viewed web sites (Barsomo & Hurtig, 2014).

Rajendran *et al.,* (2010) proposed an approach of specifying the functional and QoS requirements by reducing the complexity of matching user requests. This approach includes the broker by performing the process of selecting the web services (Rajendran & Balasubramanie, 2010). This algorithm is agreed with Liu *et al.,* (2010) and Bala & Chana (2011) which surveyed the different types of workflow scheduling algorithms and tabulated their various parameters along with tools and scheduling factors. Workflow scheduling is one of the key issues during the workflow execution especially in SLA management (Son & Sim, 2012). This workflow is followed by Verma & Kaushal (2012) whom realized that this algorithm can minimize execution cost while encounter timeframe for delivering results, and analyze the behavior of the algorithm (Arya & Verma, 2014; Verma & Kaushal, 2013; Alkhanak *et al.,* 2015). Nurika *et al.,* (2014) and Aziz (2014) proposed a genetic algorithm to calculate the specific quality of service of the available providers. This algorithm negotiates with multiple providers that are suitable for users who are concerned more on the quality of the service rather than the affordability through negotiating (Yassa *et al.,* 2013; Duerden *et al.,* 2014).

The selected algorithm has been practiced by Oprescu *et al.,* (2011) and Wang *et al.,* (2013) providing the user with a selection of options before the

execution, and based on the budget-constrained schedule according to the userôs preferences. Their algorithm estimates the budget for the case study investigated with the user-selected schedule that is executed within the given budget limitations (Oprescu *et al.,* 2012; Frincu & Craciun, 2011; Frîncu, 2014; Son *et al.,* 2013). By demonstrating the proposed algorithm that guarantees the workþow execution conforming to the deadline, Cui *et al.,* (2013) has set lodgers, and reduced the mean execution time for lodgers in a high priority while saving the execution cost for service providers.

2.7 Summary

Service Level Agreement (SLA) has a wide area of study. Hence, there are lots of areas that can be figured out to increase the potential agreement between the two parties. This chapter presents some parts of this study; performing the content adaptation strategy, the framework architectures, and the solution for the study.

This chapter conveys the SLA management generally in the content adaptation system and its relationship with the SLA environment. The chapter is concluded with the strategy in content adaptation by performing the framework architecture, and the solution of an algorithm to this study. SLA will be completed in settling with content adapted strategy after referring to the several of the QoS. Without the prior agreement, the SLA could not be implemented, and the end user could be frustrated in gaining the information in real-time.

In the next chapter, we will present a suggested model to solve the problem between the users and available service provided. This model includes the content adapted request strategies when clients surf the information over the mobile device. We, luckily, managed to improvise the algorithm, and decided to implement it in this study.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

The scope of this study is to establish an efficient and scalable basis for developing content adaptation solutions. In demonstrating this, a model of negotiation strategy will be facilitated to improvise the existed SOCA in Web Services (SOCA) (Fudzee, 2011). This framework shows the rules and the flow of the user to the service provider.

This research focuses on two main issues; 1) how to formalize quality assurance in term of service level agreement (SLA model); and 2) how to formalize negotiation of quality of service (QoS negotiation) for content adaptation services, by taking into account the acceptable waiting time for adapting content based on human psychology. This chapter will further discuss the details of the methodology used in this research study.

3.2 Scope of Study

Our research will focus on the QoS adaptation, waiting time factor, considering the needs of usersô expectation. The existing research has studied a single evaluation by developing one to one negotiation strategy (Fudzee & Abawajy, 2011b). For this research, there will be the improvement of the negotiation strategies by considering

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