QoS in Web Service-based Collaborative Multimedia Environment

M. Shamim Hossain

College of Computer and Information Sciences, King Saud University, Riyadh, KSA

mshossain@ksu.edu.sa

Abstract— **With the increasing growth of multimedia communication and web services technologies, a number of collaborative media services are being built for ubiquitous user access. However, there exist so many devices with similar functionality but with heterogeneous QoS capability. In order to have suitable services according to desired QoS, services need to be selected. This article presents the corresponding approach to service selection for collaborative multimedia environment. The experimental results show the effectiveness of the proposed approach. It also shows that our approach can work well for web services-based collaborative environment.**

***Keywords*—Media streaming service, collaborative multimedia service, QoS**

I. INTRODUCTION

The emergence of web services technologies (SOA, SOAP, WSDL, and UDDI) and multimedia technology, there is a growing demand for adaptable media services that can be rendered by a diversity of handheld devices. The devices are heterogeneous in terms of capacity and capability. The challenge is to deliver collaborative services to diversity of users who accessed media contents (e.g. video, image, audio, and other documents) through resource limited devices as media (e.g. video, image, audio, and other documents) sharing in the form of video conferencing, web conferencing, discussion service and so on.

Providing collaborative service for ubiquitous user clients is challenging due to their heterogeneity in terms of limited capability and resources, diversity, preferences and strict demand for QoS. The clients range from notebook computers to handheld devices (e.g. cell phones, notes, PDAs); have very limited varied capabilities and resources in terms of computation power, display (e.g. resolution and colors) and memory. These devices are diverse in terms of the different operating systems that they are running on, the limited set of formats (e.g. H.263, MPEG-4 and H.264) they support and finally the incompatibility of supported codec's (data formats) that two different clients communicate. The e-learning user may have different preferences, which include preferences of multimedia content, presentation and accessibility. A QoS (e.g. delay, latency, bandwidth, packet loss rate) guarantee is essential for the ubiquitous access of collaborative services such as videoconferencing, web conferencing, discussion board and so on.

To overcome the said challenges of heterogeneity, a framework is required that supports collaborative service selection, and satisfies user QoS needs to simplify the deployment of collaborative media services. The deployment of these collaborative services may include multimedia streaming service, transcoding service, conferencing service or discussion service, or instant messaging service. Currently, there exist a number of collaborative framework and system such as for e-learning [1]-[4], Virtual Campfire [5], SonART[6], Microsoft Sharepoint [7], and Alfresco [8], which are not able to fulfil the intended service demand. Virtual Campfire [5] considers multimedia as image and signal processing, which support multimedia processing such as image display and signal processing to support some sort of collaboration. SonART[5] provides networked collaborative interaction for art, science, and industry applications

In the above mentioned schemes, QoS have been addressed to a limited extent or in another domain; however, QoS, which is an essential requirement for multimedia service, has not been addressed fully. Researchers in the field of multimedia communication [1] and [9] have lately acknowledged that the performance of multimedia application relates not only to Quality of Service (QoS) at transport level but also to the collaboration. Therefore, there is a need for new adaptability techniques and methodologies for collaborative service selection for collaborative environment using metadata, multimedia, QoS and web services technologies.

We design and develop of web-services based collaborative personalized tools for e-learning users. Web service technologies (SOAP, XML, WSDL) is used to build personalized collaborative multimedia environments allowing dynamic customization and adaption of media content to access collaborative services. The main challenge with using this solution is to find the best route through the transcoding services in order to obtain the format required by the client that can maximize her/his satisfaction with the delivered multimedia content. In order to find the best route, QoS selection algorithm is required. Regarding the selection algorithm, we use ant-inspired [10] QoS routing selection algorithm that will have the ability to find the best shortest path from an ant's nest and the food source during their food search. Moreover, Ant-based approach is resistant to failures, adaptive to dynamic context, service uncertainty and service disruptions [11]. To evaluate the prototype and to justify the suitability of our proposed approach, we highlight some performance issues. For this performance comparison, we have used multi-agent programmable modelling tool-NetLogo. Performance comparison with non-biologically inspired algorithm is also discussed.

The rest of the paper is organized as follows: Section 2 gives some motivating scenario; Section 3 describes the QoS-aware web services-based service selection in a collaborative framework, detailing the framework. Section 4 presents results and analysis, and Section 5 concludes the article.

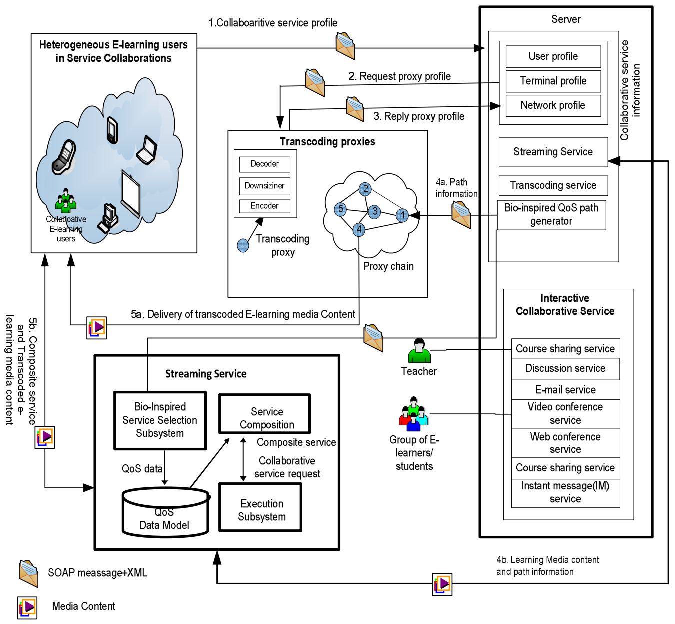

Figure 1. Proposed Media Service Based Collaborative System

II. Motivation

Fig. 1 shows a motivating scenario, where different group of mobile users participate in a live video conferencing session for a collaborative group study. Each of the communicating parties has his own surroundings that may differ in terms of devices, networks and QoS. Live video stream is captured from one user environment and is sent to another user environment for service collaboration such as video sharing, instant messaging, and conferencing services and so on. However, because of the heterogeneity of the usage environment, the captured video stream cannot be rendered to the receiving users according to their QoS demands. The solution to such an anomaly lies in considering the individual's context (e.g. collaborative service information) for delivering the content. In doing so, the captured video stream is adapted through some intermediary steps through transcoding proxies prior to delivering the content to the receiving mobile devices of the users.

III. Proposed Framework

In the proposed system, the client of each collaborative service user first queries the registry to find out a streaming service. Then, it sends a request to the streaming service with specific quality of service (QoS) parameters. The streaming service originates or creates the multimedia stream. The originated stream can either be captured in real-time by using a web cam, for example, or it can be an already stored content which the streaming service retrieves. The transcoding service transforms the media stream from one media format to another, according to the request. In addition to the incoming stream, the transcoding service should accept a file from the requester. This file corresponds to a composite transcoding service that is comprised of multiple calls for primitive transcoding services, in order to produce the final content as a reply to the client request.

When the client requires a media stream, it first searches a streaming service from the registry. The fetch request returns the Web Service Description Language (WSDL) file. The streaming service that geographically resides in the nearest point to the client is returned as a reply to the client fetch request. This is significant in order to minimize network resource consumption. Using the WSDL file, the client generates a request to the streaming service with Simple Object Access Protocol (SOAP) and sends it to the service. The request consists of a call to the streaming service, with parameters such as the format of the stream and the user location of the respective collaborative service users. When the last transcoding service in the XML file list is reached, the transcoding service directly sends its output to the client as the result of its request.

As shown in Fig. 1, the streaming service consists of three subsystems: the service selection subsystem, the service composition subsystem and the execution subsystem. The service selection subsystem is motivated from the foraging behavior of an ant colony metaphor [10] of AntNet. Through this subsystem, the streaming service is able to discover and collect QoS information about other transcoding services by dispatching ants, called forward ants, towards a targeted transcoding service. The collected QoS [9] data is used to facilitate service discovery and selection, and is eventually used to optimize the communication and selection process. The composition subsystem system uses the available information in the QoS Data Model to determine possible composition plans that satisfy the client's request of each collaborative service users. The execution subsystem establishes and handles a communication link with the first transcoding service in the plan.

One of main components to select suitable transcoding services is service selection. The detailed discussion about selection mechanism can be found from [9]. Figure 3 represents the class structure view for the proxy component that implements the Ant algorithm. AntController object in the figure is also responsible for managing the generation and reception of Ant objects. This is achieved by running two separate threads: the AntGenerator and the AntReception respectively. In addition, the AntController initializes the proxy with different properties of media services. It stores them in the ModelData object for later use. The AntGenerator thread creates a ForwardAnt object towards the destination node. To do so, the ForwardAnt decides based on the proposed selection criteria and the available neighbors through

TraversableNode object. Upon arrival of the ForwardAnt at the TraversableNode, the AntReception reads the ForwardAnt object, stacks this node into the TraversedNode under the ForwardAnt, and examines the ForwardAnt destination information against the node information, which is retrieved from the ModelData object.

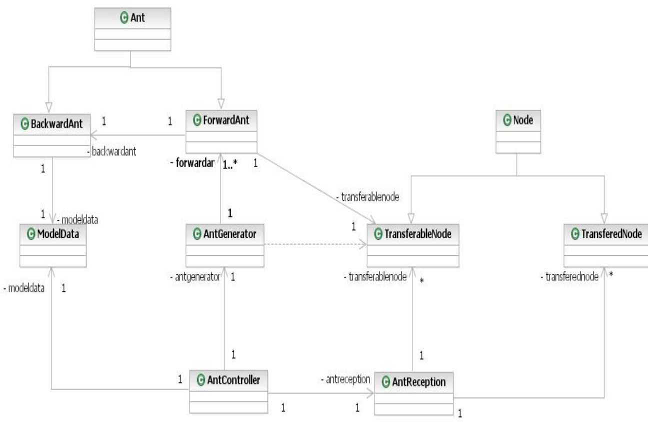

Figure 2. A class diagram for the service selection algorithm implementation

IV. Results and Analysis

In this section, at first in section IV.A, we have discussed about NetLogo to conduct the performance comparison with other competitive algorithm and non-biologically inspired algorithm, then in section IV.B we presented experimental study to show how globally optimizing biologically inspired QoS routing algorithm behaves for the service selection, where the e-learning users have access to the collaborative video conferencing sessions. Thus, we firstly conduct the performance comparisons of the algorithms and then we used the selection algorithm to a conferencing service, where e-learning users participate in collaborative learning session through multimedia conferencing session.

A. Performance comparison

In order to evaluate and compare the algorithms, we used NetLogo simulator environment. The environment is used to test the performance of the algorithms. Through NetLogo, network parameters were varied in order to study their effect on the overall performance of each algorithm. The simulator facilitates to deploy the number of service nodes and their connectivity. We use similar simulation parameter as discussed in [12]. The simulation was run on an n-dimensional node grid with a number of nodes equal to n x n and r number of node connectivity. In the simulation test bed, we considered the total number of service nodes as 49 (n x n=7 x 7) with a node connectivity of 2 (r=2) as shown in Figure 3. In this evaluation, we used success rates, latency, PSNR and frame rate as QoS performance metric. For the comparisons, we implemented the competitive algorithms [12] and the AntNet algorithm [10] in the simulator. We ran the test for 100 simulation time units.

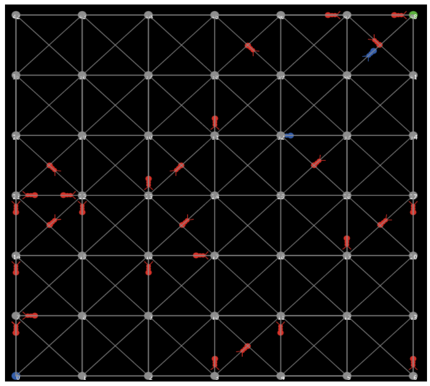

Figure 3. Simulation Environment

TABLE 1. LATENCY COPARISON

Algorithm	Latency
Ant-based algorithm	11.5
Modified Ant-based algorithm	9.8
Non-bio inspired algorithm	8.5

The performance metrics and their comparisons for each algorithm are described in the following. At first, we measured latency, where the latency is expressed as the number of hops in each route as opposed to the actual time it takes to traverse the route. The final latency of the competitive algorithms is shown in Figure. 4 and Table I.

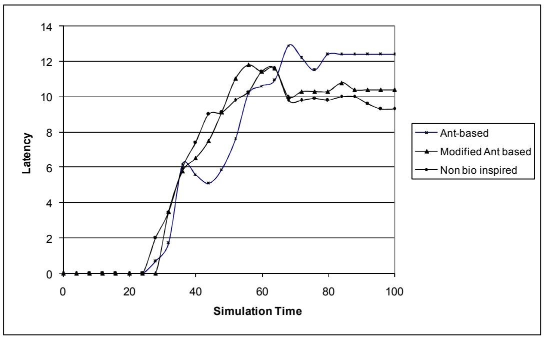

Figure 4. Latency Comparison of the three competitive algorithms

Standard deviations of the final latency for each algorithm are 2.3, 1.97, and 1.01 respectively. Non bio-inspired algorithm's low deviation shows that the readings are clustered closely around the mean which gives indication of a higher reliability of the algorithms' performance for this metric. As for the Ant-based and Modified Ant-based, the relatively higher standard deviation value indicates that forward ants require more time for selecting the destination service. It may be mentioned that ant-based algorithm is based on AntNet, while in modified Ant-based algorithm, forward ants are given forward sensing capabilities so that from any node in the network, these ants are able to sense whether connected nodes have already been traversed in their path towards the destination node or not.

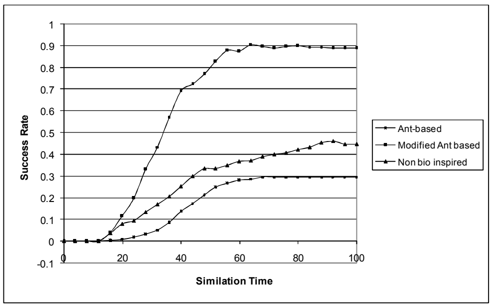

Figure 5. Success rate comparison of the three competitive algorithms

Then we measured the success rate. As shown in Figure 5, Modified Ant-based algorithm shows that it can achieve higher success rate than the remaining algorithms even with the decreased connectivity. This is attributed to the forward sensing capabilities of forward ants. Ant-based and non-bio-inspired algorithms' success rates are reduced slightly in this scenario but not significantly with Non bio-inspired algorithm maintaining a higher success rate throughout the graph.

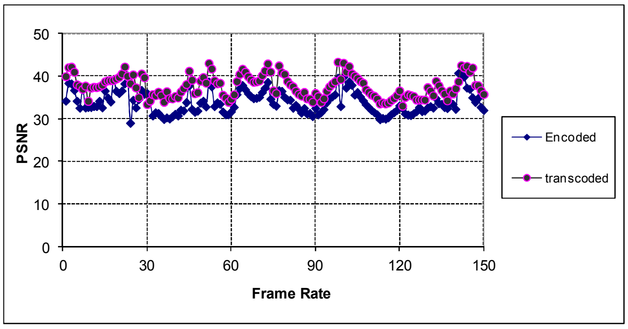

Figure 6. QoS comparison for collaborative media service

B. System Performance

The goal of this experiment is to present how the proposed service based collaborative media service framework facilitates service selection to select suitable service in order satisfy user QoS requirements in delivering learning content (media service) for collaborative video conferencing session. As for example, a client (e.g Laptop or Galaxy note) is accessing a collaborative multimedia service (e.g. audio, video, text). Suddenly, he decides to access the same collaborative session through another client, such as a PDA.

As can been seen from Figure 6 that a multimedia service of MJPEG-CIF at 30 fps with a data rate of 1 Mbps Foreman (30 fps) Sequence is encoded and transcoded (finally decoded) into different stream of H.263 at a frame rates of 30fps. The transcoded stream of H.263 CIF little bit outperforms the MJPEG-CIF in terms of PSNR (Peak Signal to Noise Ratio), however, it highly outperforms in terms of bit rate.

V. Conclusions

In this paper, we have presented a collaborative framework for delivering multimedia learning content. The framework uses collaborative service for e-learning, where learners and teachers collaboratively participate leaning sessions through emerging multimedia communication technologies such as video conferencing, web conferencing, discussion board and so on. During session, collaborative users (teachers and students) need to use different handheld devices to access the media content ubiquitously. To have this access, the proposed system being able to provide adaptive collaborative media services customized for individual users' devices.

Acknowledgment

This work was supported by the Research Center of College of Computer and Information Sciences (CCIS), King Saud University by the research project RC121259. The authors are grateful for this support.

References

[1] K. Wang, J. Ke and A. El Saddik. "Architecture for Personalized Collaborative E-learning Environment," In *Proc. EDMEDIA'2005*, Montreal, Canada, June 27, 2005.

[2] Y. Li, M. Dong, and R. Huang. "Developing a Collaborative ELearning Environment Based upon Semantic Wiki: From Design Models to Application Scenarios," In *Proc. IEEE ICALT' 2010*, Sousse, Tunisia July 5-7, 2010.

[3] Sievert, J.; Ludwig, M., "Teleteaching-based on the Multimedia Collaboration Service," In Proc. *IEEE Intl. Conf. Multimedia Engineering Education*, Melbourne, Australia, 3-5 Jul 1996.

[4] I. Giannoukos, I. Lykourentzou and G. Mpardis et al., "Collaborative e-learning environments enhanced by wiki technologies", In *Proc. ACM PETRA'2008*, Athens, Greece, July 15-19, 2008.

[5] R. Klamma, G. Toubekis, Y. Cao, D. Renzel, M. Jarke, M. Jansen, "Virtual Campfire—Cultural Heritage Management and Presentation on Mobile Devices based on Interoperable Cross Platform MPEG-7 Multimedia Web Services," In Proc. *CIPA Symposium - Digital Documentation, Interpretation and Presentation of Cultural Heritage*, Kyoto, Japan, Oct. 11-15, 2009

[6] B.-T. Oded, B. Jonathan, C. Bryan, D. Michelle, S. Gary, "SONART, The Sonification Application Research Toolbox," In *Proc. Intl. Conf. Auditory Display*, Kyoto, Japan, July 2-5, 2002.

[7] Microsoft Sharepoint. Available: http://sharepoint.microsoft.com/

[8] Alfresco. Available: http://www.alfresco.com/

[9] M.S.Hossain and A. El Saddik, " QoS requirement in the Multimedia Transcoding Service Selection Process," *IEEE Trans. Instrum. and Meas.*, Vol. 59, No. 6, pp. 1498-1506, June 2010

[10] G. Di Caro and M. Dorigo, "AntNet: Distributed Stigmergetic Control for Communications Networks," *J. Artificial Intelligence Research (JAIR)*, vol. 9, pp. 317-365, 1998.

[11] Di Caro G, Ducatelle F, Gambardella LM, Rizzoli L (2006) Building blocks from the biology for the design of algorithms for the management of modern dynamic networks. *ECRIM News*, Special Issue on Emergent Computing 64(Jan): 34-35

[12] M.S. Hossain, D. Elghobary and A. El Saddik, "Ant Based Routing Algorithms for Resource Constrained Networks," in *Proc. IEEEI2MTC*' 10, Austin, TX, USA, May 3-6, 2010