Towards Building File Sharing and Adaptation Service for Advanced Collaborating Environment

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Abstract— **Sharing files is very common in collaborative environment. Users may want to share each other's file for more effective and meaningful collaboration. Sometimes it would be preferable to adapt the file so that it can provide the required information to users with minimal overhead. Moreover, users may not want to share files in their original format. Due to device heterogeneity file sharing in original format is less meaningful. Therefore, data adaptation is needed to have the effective file sharing among users. In this paper, we propose a framework for file sharing and adaptation to have effective collaboration among users in advanced collaborating environment. This will certainly enhance the degree of collaboration. Moreover, we propose a hybrid approach for adapting data which considers user preferences and device capabilities at the time of data adaptation. The goal of this adaptation approach is to provide the best possible adaptation strategy based on user preference and device capabilities. Moreover, we discuss about our first prototype implementation here. At it's current stage, our prototype only deals with image files. Our prototype implementation realizes our designed framework and demonstrates the viability of our approach.**

I. Introduction

Due to the advancement in the field of networking and multimedia technology, The traditional video conferencing becomes obsolete now-a-days. People in different places want to interact with each other in a more convenient and meaningful way. That is why, the concept of advanced collaborating environment is essential to provide interactive communication among a group of users. The ACE aims to bring together the right people and the right data at the right time in order to perform a task, solve a problem, or simply discuss something of common interest [1]. Some early prototypes of ACE have been mainly applied to large-scale distributed meetings, seminar or lectures and collaborative worksessions, tutorials, training etc.

In course of interaction, users may want to share files which may differ in their type and size. Therefore, sharing various types of data is a major user requirement. Moreover, adapting the content of the file is required for device heterogeneity. This type of adaptation is based on the target device alone, also known as device-centric approach. Device-centric adaptation only considers the capabilities of a device and adapts data in such a manner which will be renderable in the target device. In this case, the system is most likely to produce the highest quality adaptation. But, we have to also consider the user preferences while adapting data. The goal of the user-centric approach is to generate an adapted version such that the version itself is a best match to user preferences and thus satisfying the user.

In this paper, we propose a framework for data sharing and adaptation in ACE. Our framework provides a balanced approach of data adaptation considering user preference and device capabilities. We store user preferences about various dimensions of a file type as well as user device capabilities. In our design, we have used cosine similarity measure [2] for finding out the best possible adaptation scheme. For the limitation of space, the detail mechanism for decision engine have not been discussed here. We have developed a prototype implementation based on our design which utilizes the access grid platform. The prototype implementation allows the user to share their desired image file in an adapted form based on the best match adaptation scheme.

The rest of the paper is organized as follows. Section 2 begins the discussion of related work. In section 3 we discuss about advanced collaborating environment followed by our proposed framework in section 4. Our prototype implementation has been discussed in section 5. Finally, we talk about some future work and conclude in section 6.

II. Related Work

Many projects have been initiated for developing interactive collaboration. Gaia is a middleware infrastructure for Active Space used to prototype the resource management and provide the user-oriented interfaces for such physical spaces populated with network-enabled computing resources [3]. The Gaia extends typical operating system concepts to include context, location awareness, and mobile computing devices/actuators (like door locks and light switches). The BlueSpace project [4] has been developed with an aim for improving the comfort and productivity of worker by providing an adaptive working environment, which regulates climate and lighting, supports spontaneous collaborative work sessions, and protects from unwanted interruptions. These two aforementioned research projects have significant influence for developing collaborative applications for advanced collaborating environment.

Moreover, several research papers have been published for providing effective and efficient data adaptation. The principles of device-independence were addressed in [5], where, for achieving the independence, it should be possible for a user to obtain a functional presentation via any access mechanism.

The work on device-independent access [6] offers some good insights on handling the variability of client devices which amounts to staying away as much as possible from creating content versions specifically for individual device types. The study in [7] follows the same way and recommends that clients can be viewed as varying along three important dimensions: network, hardware and software. Content adaptation systems can make decisions on the response content versions or adaptation strategies based on some situational context. Some works can be found in [8], [9] mentioned about this trade-off policy. The judgement for this trade-off policy can also be derived using some score based evaluation where users can assign a score to different adaptation scheme to show their preference on the decision of adaptation [10], [11], [12]. But in practical situations, it might be difficult for users to assign a score to each adaptation scheme. To make this assignment automatic, the approach resource-based content value was proposed [10], [11], [12]. In this approach, the content value is dependent upon the resources in the client device that can be used to render the file, not the degree of satisfaction perceived by a user.

We propose in this paper, a framework for data sharing and adaptation service which enables user to share files from others and those files will be adapted according to user preferences and device capabilities. The main difference from the previous works is our approach considers user preference as well as device capabilities. We try to make a balance among device-centric and user-centric data adaptation approach so that the best adaptation strategy will be followed to adapt data.

III. Advanced Collaborating Environment

The primary intention of ACE is to provide advanced collaboration among users. Figure 1 depicts the major entities related to this environment [13].

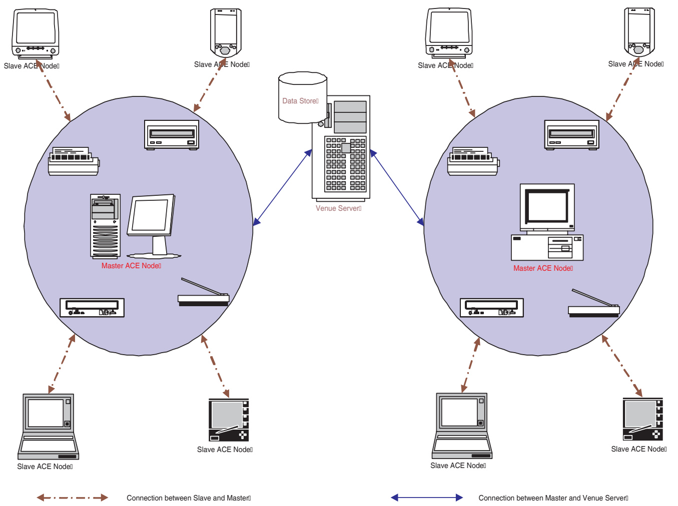

Fig. 1. Master and Slave ACE nodes in Advanced Collaborating Environment

- ACE Node: Each ACE node has a couple of audio/video/interaction devices, LCD/projector/tiled display systems, and a number of support machines. All machines of each ACE node are connected to 1-10 Gbps high-performance LAN and ACE nodes are again connected by 10Gbps WAN. ACE nodes may have different node capabilities like mobile node, conference room node or large-scale auditorium node. For example, some ACE nodes are based on laptop PCs while the others consisting of a powerful set of machines and devices.
- Master ACE Node: It is a kind of ACE node which has the capability to directly communicate to Venue through venue client as well as Venue Server. From the device configuration point of view, it has higher configuration as accessories like HD camera, microphone etc. are attached to this node.
- Slave ACE Node: Slave ACE node has less capabilities compared to Master ACE Node in terms of device configuration as well as it cannot communicate to Venue and Venue Server directly. Slave ACE node will be connected to a Master ACE node and all the functionalities needed for users in Slave ACE node are achieved through Master ACE node.

One of the major user requirements in advanced collaborating environment is sharing files among users. Specially, since users at slave ACE nodes don't have the direct connectivity to Venue and Venue Server, we need to provide file sharing service to users at slave ACE nodes. Files exist in different forms and size. Therefore, for effective and efficient file sharing sometime these files need to be adapted from one form to another. At the time of data adaptation, we need to consider the user preferences and device capabilities. In the next section, we will discuss about our proposed framework for file sharing and adaptation considering user preferences and device capabilities.

IV. Proposed Framework for File Sharing and Adaptation

File sharing and data adaptation service is very much necessary to provide effective collaboration among users in advanced collaborating environment. File sharing service will be demonstrated by the realization of data adaptation service. In this section, we provide the definition of file sharing and data adaptation service as well as the UML diagrams designed for the realization of these two services. Moreover, we will talk about the decision engine and how we will use the user preferences, device profile to provide the best possible adaptation method.

A. File Sharing Service

File sharing service enables users to share each other files in an interactive manner. Files are stored physically at data store in venue server. User at any personal ACE node (slave mode) can initiate file sharing service. As a result, a copy of the file in appropriate form will be stored in the local storage of user device.

Figure 2 depicts the block diagram of file sharing service. At first, the user will interact through slave file sharing service. The slave file sharing service will pass the venue URL to

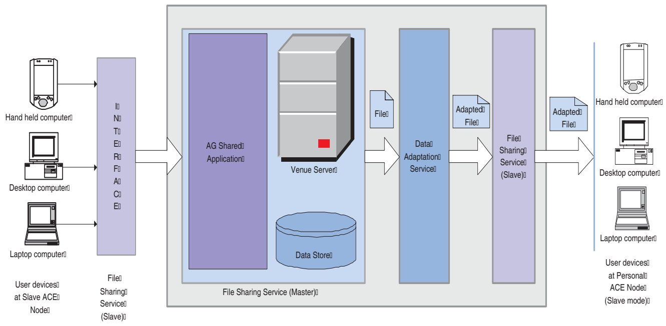

Fig. 2. Block Diagram of File Sharing Service

master file sharing service. The master file sharing service is an AG [14] shared application. It will retrieve the file from venue data store and then send it to the adaptation service for the best possible adaptation.

B. Data Adaptation Service

The principle concern of data adaptation service is to adapt data according to the user preferences and device capabilities. User's preferences will be stored earlier. For a particular file format, we will identify some quality dimensions. Users will put their preference order on different quality dimensions. At the time of actual adaptation we will also consider the target device capabilities. We have a set of converters having different adaptation settings. We will choose the converter having the highest similarity considering user preference and device capabilities. We use cosine similarity measure for this purpose.

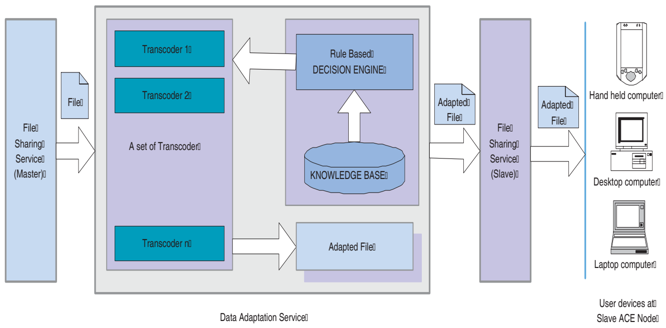

Fig. 3. Block Diagram of Data Adaptation Service

Figure 3 refers the block diagram of data adaptation service. Here, we will choose the adaptation strategy based on the decision provided by our decision engine. Based on our decision logic the decision engine is supposed to provide the best adaptation scheme for that particular file.

C. UML Diagrams of Proposed Framework

For our proposed framework, we have prepared class diagram, sequence diagram and use-case diagram. Our proposed framework involves with three main classes. These are given below.

- File sharing service (master)
- File sharing service (slave)
- Data adaptation service

The difference between file sharing service (master) and file sharing service (slave) lies in their function. File sharing service (master) will act as an AG [14] shared application. It's main function is to retrieve files of a specific type and then download the file from the venue server. Then it will call data adaptation service for appropriate adaptation. The file sharing service (slave) provides the user interface through which user can interact with the ACE environment. It will communicate with specified venue by calling the master file sharing service.

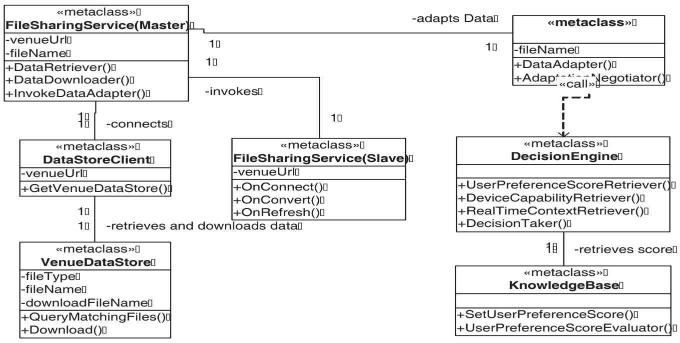

Fig. 4. Overall Simplified Class Diagram

Figure 4 depicts the class diagram of the proposed framework. In our class diagram, the class 'DecisionEngine' is responsible for providing the best possible adaptation scheme. The function 'DecisionTaker()' will take the decision based on our decision logic explained later. The function 'DataAdapter()' belongs to Data adaptation service class will convert the according to the provided adaptation strategy. Knowledge base will hold the information regarding user preferences and device capabilities. Master file sharing service class will invoke the venue data store in order to retrieve the desired file. Slave file sharing service provides an user interface to invoke the services.

Figure 5 refers the sequence diagram of receiving the adapted file by users. It shows the sequence of execution of different classes and connectivity among them.

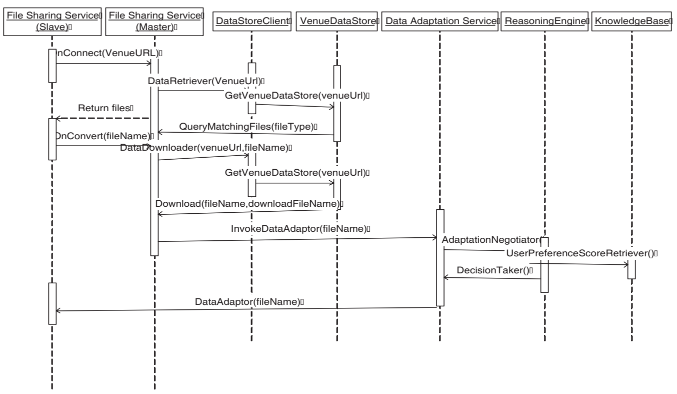

Fig. 5. Sequence Diagram of the Overall Framework

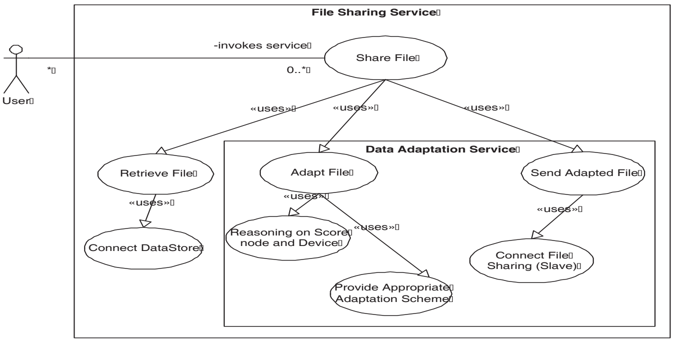

Fig. 6. Use Case Diagram

Input: V_{up}, $\{V_{cp}\}$, *Device_color_depth*, *Device_screen_resolution*, *Original_Image_Resolution*

Output: ***Best match*** V_{cp}

```
FOR each Vcp in {Vcp}
      COMPUTE SIM
      COMPARE SIM >= MAX_SIM
            IF TRUE, COMPARE SIM = MAX_SIM
                  IF TRUE, COMPARE DIST < MIN_DIST
                        IF TRUE, COMPARE Device_color_depth supports Ncp-color
                              IF TRUE, MIN_DIST = DIST and Best match Vcp = Vcp
                                    BREAK
                              ELSE, CONTINUE
                        ELSE, CONTINUE
                  ELSE, COMPARE Device_color_depth supports Ncp-color
                        IF TRUE, MAX_SIM = SIM and MIN_DIST = DIST and Best match Vcp = Vcp
                              BREAK
                        ELSE, CONTINUE
            ELSE, CONTINUE
```

Fig. 7. Algorithm for Decision Engine

Figure 6 shows the use case diagram. The initial goal of the user is to share files from other users. This task can be decomposed into three sub tasks such as retrieve file, adapt file and send adapted file. The sub tasks can be decomposed into further for the ease of understanding.

D. Decision Engine

The decision engine is the central part of data adaptation service. Data adaptation service will adapt data according to the decision provided by the decision engine. Decision engine will take decision based on user preferences and device capabilities. Here we give the brief outline on the decision mechanism.

The preference values provided by the user on different quality dimensions (e.g. color, scaling, sharpness for image file) are turned into a vector known as User Preference Vector Vup. Based on the different quantization steps for a particular quality dimension, we have a number of converters. We express each of these converters in a form of Converter Preference Vector Vcp. At first, we calculate the cosine based similarity between Vup and each of the Vcp. At this point, we are also considering whether the converter settings will be supported by user device. We choose the converter having highest similarity. If multiple number of converters have the same similarity, we choose the Vcp which has the smallest distance from Vup. This is how, our decision engine will provide the best match converter to adapt a particular file based on user preference and device capabilities. Figure 7 shows the formal algorithm for the decision logic.

E. Ontology-based Database

Ontology-based database can be used to store the user preferences and device capabilities in order to provide best possible adaptation scheme. Our proposed ontology for the aforementioned task has the following shape.

In figure 8, the rectangle shows the concepts and the ellipse represents the properties. Here the main concept is user. User may have personal profile, preference profile and device profile. These classes or concepts are used to hold the information about the particular domain.

- Personal Profile: The concept personal profile is used to hold the user personal information like name, affiliation, e-mail etc.

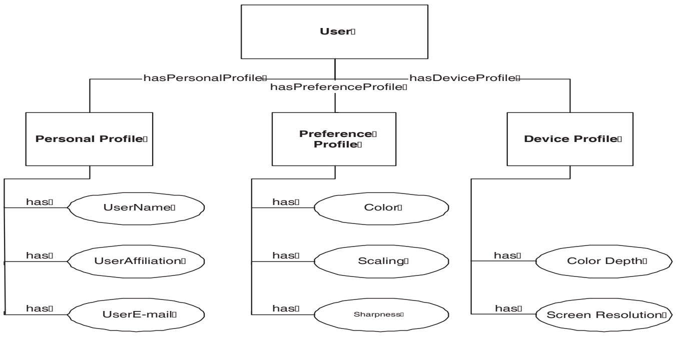

Fig. 8. Ontology for Concept User

- Preference Profile: Preference profile will hold the user preferences about various quality dimensions. As for instance, color, scaling, sharpness etc. are the quality dimensions for a particular file format.
- Device Profile: It includes properties like device color depth, screen resolution etc. to identify device capabilities to render one particular adaptation strategy.

V. Prototype Implementation

Our prototype implementation currently only deals with image files. Our prototype allows users at slave ACE nodes to share adapted files from other users. We have implemented file sharing service (slave), file sharing service (master) and the data adaptation service which will adapt the image file based on user preference and device capabilities. We have three modules in our current prototype implementation. These are:

- Master File Sharing Service: It has been implemented as an AG shared application. That is why, it needs to be implemented in Python. This module retrieves file from Data Store at venue server and sends this file for appropriate adaptation.
- Slave File Sharing Service: It has been implemented as stand-alone application. We implemented this module in python. It provides the interface to the user for entering venue URL and selecting the desired file.

Fig. 9. Connecting Master ACE node through Slave File Sharing Interface

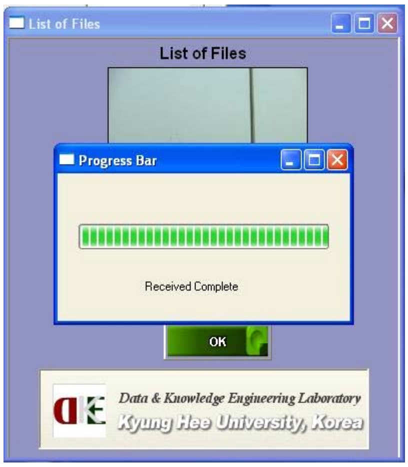

Fig. 10. Adapted File Received Confirmation Screen

- Data Adaptation Service: It is a stand-alone application. It has been also implemented in python. Currently, this module has a decision engine which provides the appropriate adaptation scheme for converting the original file.

At the beginning, the user enters his/her e-mail address and preferred file type for sharing. Then, he/she presses the appropriate button for connecting Master ACE node (see figure 9). After pressing the connect button the master file sharing service will connect to the venue data store and retrieves file of user mentioned type. Then, the user will select one of the files. The specified file will be downloaded through the master file sharing service, the decision engine takes the decision of selecting appropriate adaptation method and then it will be passed to the data adaptation service. The function DataAdapter() takes the file and convert it based on the decision provided by the decision engine. Then adapted file will be sent to Slave ACE node by master file sharing service and the adapted file will be stored into the local storage of slave ACE node. Figure 10 shows the confirmation screen that adapted file has been successfully received by slave ACE node.

VI. Conclusion and Future Work

In this paper, we proposed a framework for file sharing and adaptation service in advanced collaborating environment. File adaptation is very much necessary because of the differences in user preferences as well as device capabilities. Our main contribution is to integrate file sharing and data adaptation service into the ACE environment as well as propose a balanced approach of adapting data. We have considered user-centric, device-centric approach for data adaptation and devise a decision logic which follow the hybrid approach to provide the best possible adaptation scheme. Our prototype implementation currently provides the file sharing and data adaptation service which enables users to share adapted files. Our future goal is to provide this service supporting other kinds of files too. Moreover, we are planning to provide more rich GUI and extended functionalities to users. This paper proves the necessity of file sharing and data adaptation service for ACE environment and also provides a framework for realizing these services.

Acknowledgement

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