AN ARCHITECTURAL FRAMEWORK FOR COLLABORATION OF HETEROGENEOUS COMMUNICATION DEVICES USING WAP AND MOBILE DEVICE AUGMENTED (MDA) GATEWAY INTEGRATION

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Abstract

Within the last couple of years, the challenge of displaying collaborative multimedia information has become very important with the large diversity of communication devices such as Personal Computers, laptops, notebooks and handheld devices. The shared data and information may be presented with different views depending on the communication device used by a particular collaborator. The use of various web tools (HTML, WML etc) offers some solutions to the problem but if the target application requires more complex features such as rich multimedia data than is manageable using HTML or WML format, something else need to be done. In this paper, we propose a framework that integrates WAP and MDA Gateway to support collaboration among virtual teams and nomadic workers using heterogeneous communication devices. We then discuss an approach for augmenting mobile device small screen capabilities with surrounding large screen display devices.

Keywords: Collaboration, Heterogeneous devices, WML, Composite Devices, WAP, MDA Gateway

1. Introduction

The growth of the World Wide Web (WWW) in the last couple of years has been enormous and this has made users to embrace the Internet as a standard infrastructure over which a variety of collaboration application and services can be deployed. Collaboration is the process by which teams of people in separate (remote) locations work together, share, discuss and exchange textual and multimedia information. The web is assuming a central role in the way people share information, hence it has been adopted as one of the major media for supporting remote collaboration. For remote collaboration to be widespread, heterogeneous communication devices are often employed, and these are devices such as PCs, Laptops, Notebooks, TV, Handheld devices(cell phones, mobile phones, Personal Digital Assistants (PDAs), pagers, palm top computers, etc) used for exchanging information between remote locations. Increasingly more people and organizations using these devices desire to collaborate in order to improve their communication and productivity. However, one has to take into account that the different users may not be equally equipped in terms of output and input capabilities. Mobile devices often have limited screen display sizes and limited capacity to support audio and video data, and also impose restriction on user input. The restrictions on the input may be due to their small

size, miniaturized keyboard (e.g. having keys with multiple functions), sparse capabilities for the capture and recognition of voice and video input. Mobile devices also have limited memory and weak CPU – power when compared to a digital computer. Usability is still a concern with regards to displaying complex graphics on the small screen handheld devices. It is therefore pertinent that something be done to overcome communication barriers imposed by the use of heterogeneous communication devices. Integrating a wide range of communication devices to widen the scope of participants that want to collaborate is a possible solution to these challenges.

Several approaches have been developed to facilitate collaborative systems. In the mobile telecommunication sector, collaboration has been successful with wireless access to the Internet through Wireless Application Protocol (WAP). WAP is a communication protocol and an application environment that enables Internet and web access from wireless handheld devices, with limited display and data capabilities such as pagers, PDAs, mobile phones and other wireless terminals. The WAP gateway serves as an intermediary between the wireless WAP-specific content and WAP client. It also reformats world wide content for display on WAP-based wireless handheld devices. The WAP standard is controlled and developed by the WAP Forum, an industry alliance of more than 200 telecommunication hardware, software, network and peripheral companies[8].

As far as usability is concerned, input, process and display of rich multimedia messages such as photographs, picture messages, maps, electronic postcards, audio and video clips, etc, on small screen handheld device is still a challenge. The capabilities of the handheld device need to be augmented with the surrounding large screen display devices to enhance its functionalities with regards to Multimedia Messaging Services (MMS). The technology of Composite Device Communication Environment (CDCE)[2,6,10] which employs the assistance of the surrounding output devices (Television (TV) set, PCs, etc) to view complex multimedia content can be used. In [6], Composite Device is defined as the composition of available hardware resources that surround user's current location, such as PCs, workstations, high-resolution monitors, TV set etc.

The Multiple Device Augmented (MDA) system being proposed in this paper derives from the CDCE. The gateway that manages the multiple devices (same meaning with composite devices) is the MDA Gateway. The MDA gateway operates as an intermediary between the composite devices, Web server and mobile devices. Depending upon the user's current position and situation, the composite device framework provides a computing infrastructure to incorporate and to outsource/redirect computing tasks to computing or physical resources within the close vicinity. An integrated gateway comprising of WAP and MDA functionalities that support collaboration among users of diverse communication devices is most likely to be quickly and widely adopted as a result of its obvious convenience and flexibility advantage.

This paper proposes a framework that integrate WAP and MDA gateway with surrounding output devices to support collaboration among users of heterogeneous communication devices. It then discusses an approach for augmenting small screen mobile device capabilities with surrounding large screen output devices, to facilitate better display of rich multimedia content.

This remainder of this paper is structured as follows: In section 2, we have a review of related work. The research motivation is discussed in section 3. Section 4 describes the proposed system in terms of architecture and benefits of the integrated WAP and MDA gateway. Finally, a discussion about future research areas and conclusion is given in section 5.

2. Related Work

A number of collaborative systems related to the work described here have been reported in literature. Most of them address collaboration based on textual and non-rich multimedia data using
standard computing devices and mobile devices. Collaboration based on mobile devices and surrounding display devices assisted view, has not been fully exploited.
In [7], a prototype that enables PDA to interact with a TV set was developed. The television responds to PDA output and is used for the presentation of visual images and videos. To overcome a small screen mobile device display constraint, a Composite Device Computing Environment(CDCE) framework was developed in [2,10], it enabled surrounding output devices and computing resources to render and display requested multimedia data. In [6], an ubiquitous computing infrastructure that facilitates nomadic users to access rich multimedia contents using Small Screen/Composite Device (SS/CD) was developed. In [5],
chatting and instant messaging tools were reported. They are tools for keeping people connected and notified. They are targeted towards subscribed users who want to chat in a private network, allowing members of the community to meet, discuss and exchange messages. Some of the players in this field are AOL's Instant Messenger (AIM), Microsoft MSN messaging service and Yahoo Messager. Short Message Service (SMS) also reported in [5] is a very popular service today and has been one of the first messaging tools available for mobile terminal. It is very convenient but has limitations that make it unsuitable technology for rendering collaboration services. These limitations include: 1) unidirectional messaging,
2) a limited fixed length message (160 characters), 3) a message can only be sent from one point to another point. In [3], a framework was proposed for developing adaptive application to the clients computing platform for ubiquitous collaboration. The Collaborator which is a software framework developed by European research project aims at specifying and developing a software distributed environment to support efficient synchronous collaborative work between teams was reported in [4].

The novelty of the approach presented in this work in contrast to existing approaches derives from the integration of an MDA gateway and WAP in facilitating communication of heterogeneous devices especially those within the vicinity of a mobile user.

3. Motivation

We wish to acknowledge the activities of the mobile industry and make the following observations on the future trends of mobile technology.

- Small screen device capabilities will change towards more processing power and high-resolution
  display[6].
- Wireless network and protocol will improve towards more bandwidth. For instance, the third Generations (3G) of wireless network protocols such as General Packet Radio Service(GPRS) and Universal Mobile Telecommunications System(UMTS) offers a much higher bandwidth in comparison to existing previous technologies such as Code

Division Multiple Access(CDMA). The 3G has support for Enhanced Data for GSM Evolution (EDGE) services, a mobile network radio technology that allows GSM network to offer 3G services with existing frequency [9]. The 3G also combine and support
several communication devices-mobile phones, microcomputers and television.

- Due to the requirements of the handheld devices to be pocket-sized, the maximum physical size of the small screen display will remain the same. While it is likely that the handheld device screen resolution and quality will improve, the display size is anticipated to remain constant for a longer period[6].

Being aware of the display limitations and thus the limiting graphical user interface of small screen devices particularly for multimedia data, our focus in this paper is to propose an architectural framework that users of heterogeneous devices can use to communicate using a gateway platform that augment the capabilities of handheld devices with surrounding large screen display devices.

4. Systems Description

In describing the proposed system, we here present the architecture and benefits of the system.

4.1 WAP and MDA Architecture

We have combined the idea in [2] which utilizes arbitrary computing and output devices, such as PC's, TV sets etc, if any is available within the surrounding environment to perform multimedia information/service requests, with tailoring and shrinking capabilities of information of WAP to fit the mobile devices in case no computing or output devices is available within the surrounding environment.

The essential components of the WAP and MDA architecture are(see figure 1):

- WAP Clients: This component is the client device, which includes the wireless handheld devices such as PDAs, mobile phones etc, that a subscriber or a mobile user will use to access the Internet. This client device will have a WAP-based micro-browser(analogous to the desktop web-browser) that will serve as the primary user interface, through which the subscriber will make requests for Internet-based information. Three main and important functions are primarily carried out by the mobile devices. First, the mobile device is used as an interface to access information and services provided by the Web server through the WAP and MDA gateway. Second, the mobile device detects available composite elements(TV, PCs etc) in the close vicinity and informs the gateway. Third, the mobile device task is to control the invoked services and to provide users possibilities to interact with requested information and services.

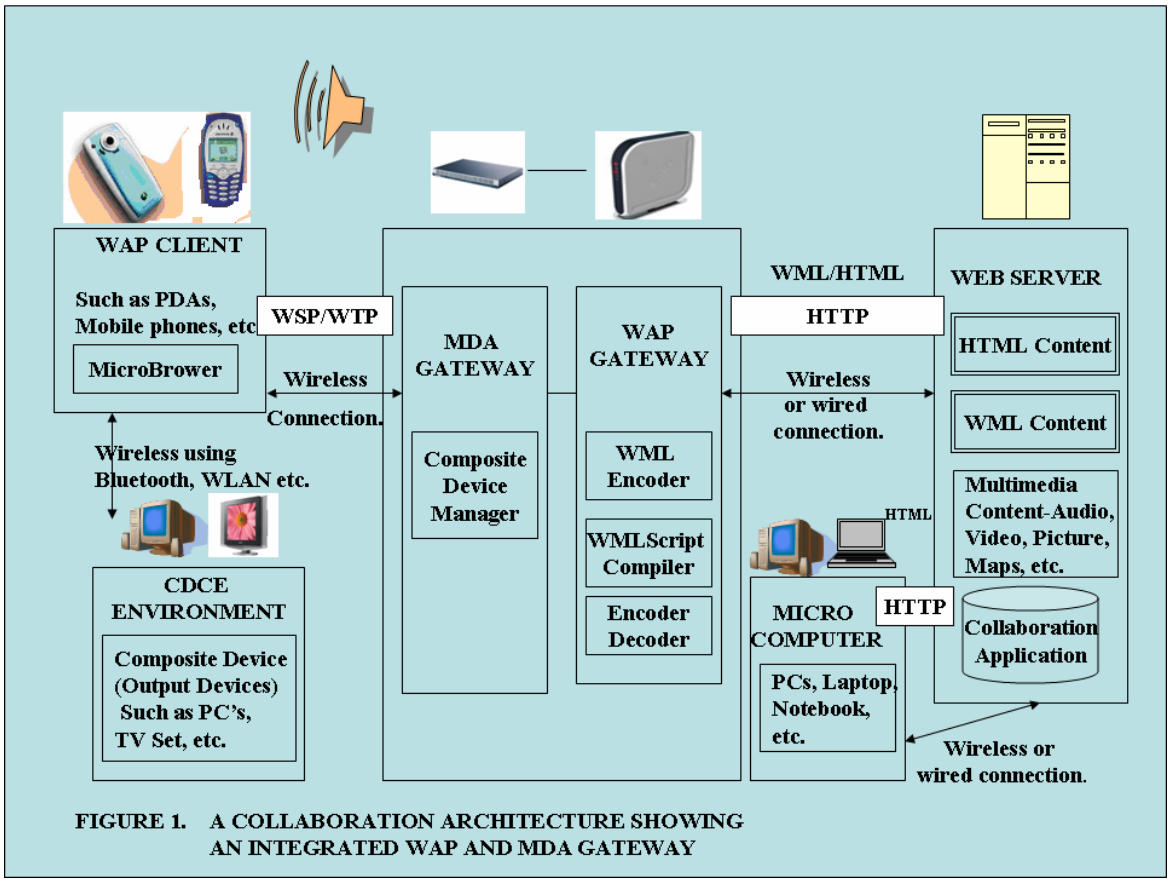

FIGURE 1. A COLLABORATION ARCHITECTURE SHOWING AN INTEGRATED WAP AND MDA GATEWAY

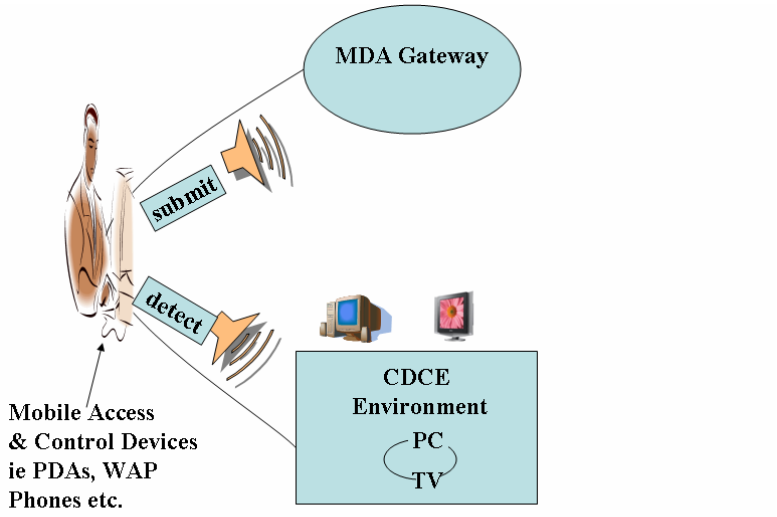

FIGURE 2. AN MDA GATEWAY ARCHITECTURE SHOWING MOBILE ACCESS AND CONTROL DEVICES

- WAP and MDA Gateway: This is one of the important components of the architecture. The gateway is the interface between WAP clients (mobile devices), composite devices and Web server. The functions of the WAP gateway includes: 1) processing of encoded requests for Internet-based information from the mobile devices, 2) decoding/encoding of task, 3) conversion of Wireless Session Protocol (WSP) to HyperText Transfer Protocol (HTTP) and 4) transformation of HyperText

Markup Language (HTML) to Wireless Markup Language (WML) content. WAP also defines a scripting language called WML Script(analogous to Javascript on desktop computers), that extends micro-browser functionality with small applications called scripts. The WML Script compiler does the transformation/translation process from HTML to WML and vice visa.

The composite device manager, the subcomponent of the MDA gateway, manages and maintains the database of available composite elements that can be used to perform certain tasks. Important is the knowledge of the capabilities of each composite element e.g. if a PC has a soundcard and speakers or a monitor has a high color resolution. It assigns the selected services and information request to the most appropriate composite device to perform the task.

- WEB Server: The Web server stores the actual value-added information and content that subscribers wish to access. This content, if in HTML, must be encoded with WML by the WAP gateway for viewing on the WAP clients. The content may also be stored on web-servers in WML, allowing the WAP gateway to pass WML documents directly to the WAP client. Collaboration application may be developed using HTML or WML scripts which may contain textual or multimedia data.

  The operation of the WAP and MDA gateway is such that when a mobile device requests content from the Web server through the MDA gateway and WAP gateway, the WAP gateway retrieves the content directly from the Web server if in WML format, but does reformatting and translation of the content if in HTML format. The requested content will subsequently be returned by the WAP gateway to MDA gateway to determine the nature of the request. For simple output request, the MDA gateway will deliver the content to the small screen mobile device, otherwise it will be redirected to the nearest large screen display device within the vicinity of the mobile user (particularly for rich multimedia request), such as audio/video clip, pictures, maps, photographs, etc.
- Micro Computers: The microcomputer is also one of the clients to the Web server, it uses PCs, Laptops, Notebooks, etc, to access the HTML content of the Web server through HTTP.
- The CDCE Environment: The CDCE comprises of the collection of the output devices

(composite devices) within the vicinity of the mobile user, it includes PCs, TV set etc.

One essential element of the CDCE as seen in figure 2 is a mobile access and control device, which detects the existence of surrounding devices, invokes services on these devices and controls the executed processes. Another distinguished component is the MDA gateway module which is responsible for the management of the composite device and the supply of information and services. The access and control device of CDCE is a mobile device that can be a PDA, WAP phone, etc, which has the ability to detect available surrounding devices as well as to identify its capabilities and availability. The knowledge of the device composition at current location is transmitted to the MDA gateway module that offers different multimedia services to its usage. The user has to submit the selection to the gateway. The gateway assigns the services to appropriate output device for the display and calculates a proper order to execute the services. Optionally, the user can manually influence this process by adjusting the assignment.

The short range communication between the mobile devices and composite devices can be realized using wireless proximity network technology i.e. Wireless Local Area

Network(WLAN), Bluetooth etc. Communication between WAP client and the gateway is wireless, that of the gateway and the Web server could be wireless or wired. The Web server and the microcomputer could communicate through wired or wireless connection.

The WSP specifies compression techniques to provide efficient transmission of the request and response. It also allows for negotiation of capabilities between client and server. While the Wireless Transport Protocol (WTP) is responsible for packet segmentation and reassembly, and for acknowledgement/retransmission of packets[1].

To interact with the system, the methodology used in [4,6] can be employed. The interaction with the virtual mix of computing resources maintained by CDCE as Composite Device using a mobile device is a crucial point of the concept.

To interact with the CDCE environment three phases can be used as follows:

i) The detection phase that determines surrounding output devices.
ii) The construction phase, when the computing resources are constructed to create the composite devices.
iii) The interaction phase, where the user interacts with the invoked services via the mobile device.

Another influence related to the user interaction issues in the interaction phase is the different control modes that can distinguished[6]:

i) Abdicative -The mobile device hands over the control to the output device.
ii) Cooperative - Mobile device and input capabilities of the output can jointly be used to control the application.
iii) Exclusive - The only input device is the mobile device.

4.2 Benefits

An Integrated WAP and MDA Gateway platform will open up new benefits to collaborators and users involved in sharing and exchanging information(including multimedia). It offers:

i) Immense assistance to nomadic workers on the move (i.e. construction and telecommunication

engineer, etc), workers on separate sites working and troubleshooting simultaneously on an equipment.

ii) Fast access to business data, for instance, it provides doctors and nurses with the ability to access

patient data at any time while being mobile within the hospital vicinity. This kind of communication

infrastructure facilitates and provides a better point of care services at patient's bed[6].

iii) Enormous assistance to users on mobile commerce and other business transaction purposes ie a prospective home buyer could use a Personal Digital Assistant (PDA) to access a home information service on an Interactive Television(ITV)[7].
iv) Effective facility for video conferencing and virtual cooperation.
v) Deployable ubiquitous computing environment in which different kinds of computers and devices surrounding users are engaged to provide computing services.
vi) Mobile users access rich multimedia content and services without having to shrink or to tailor the content to match the capabilities of the mobile devices.
vii) Users access to rich multimedia contents and services without having to compromise much in quality and diversity.
viii) The creative activities of collaborators are enhanced due to the availability of bigger size output device.

5. Conclusion

In this paper, we have proposed an architectural framework to facilitate virtual teams and nomadic workers to collaborate and exchange textual and multimedia content. The integration of WAP and MDA gateway facilitates an enhanced view of information. The MDA component of the gateway allows complex multimedia data requested by mobile devices to be redirected to the nearest surrounding large display devices for better view. Other issues connected to security and privacy can be addressed in future work.

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