Adaptive Mediation Architecture for Mobile- Government Framework

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ABSTRACT

Smart mobile devices that support internet access are widely used nowadays. Those devices have different capabilities based on the manufactures and the model. This paper proposes a new framework for adapting the content of Mobil-government services with respect of four contexts; personal, device, connectivity and location contexts. The framework is based on a 3-layer mediation architecture that uses XML as semi-structure mediation language. The flexibility of the mediation and XML provide an adaptive environment to stream data based on the capabilities of the device sending the query to the system.

Key Words: *Mobile -government, Content Adaptation, User Context,* E-government, mediation.

1. INTRODUCTION

In the age of technologies, people are using technologies in order to do their day-to-day transactions. One of the important transactions is governmental transactions such as follow up applications, query their records, submit applications… etc. These data are distributed over many ministries and departments that may use different applications and apply different restrictions on accessing data. In other words, the data sources are heterogeneous in the structure and naming conventions.

On the other hand, people nowadays use different technologies. Moreover, they enjoy using mobile technologies such as mobiles and PDAs. Those devices have capabilities similar to personal computer in terms of internet connection, browsing, and typing. Unfortunately, those devices have different operating systems and different capabilities such as different connection speed, and different resolutions.

This scenario leads to a new phenomenon that emerged from recent proliferation of mobile devices and wireless technologies called Mobil-government. Many governments started to adopt mobile usage habits as well as the wireless technologies to meet the rising expectations of the public for better services [4].

Mobile-government (M-government) extends E-government benefits by releasing the latest edge of technologies from its minimal requirement which is a personal computer (PC) to wireless technology. M-government is considered as a supplementary approach to deliver governmental services from distributed, heterogeneous data sources through different transmission channels and technologies anytime and anywhere. As shown in Figure 1, M-government is a subset of E-government [25]. For example, in [3], the authors define E-government as "the use of information and communication technologies (ICTs) to improve the activities of public sector organizations" and they described M-government as E-government with those ICTs that are limited to mobile and wireless technologies such as cellular phones and PDAs (Personal Digital Assistants) connected to wireless Local Area Networks (LANs).

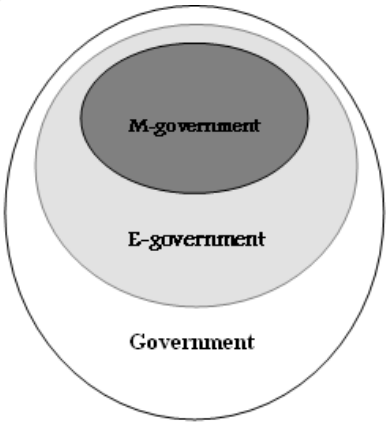

Figure 1: M-government As Part of E-government

In This paper we aim to proposal a framework solving the aforementioned two problems: accessing heterogonous data sources and manipulating different presentations for mobile devices. The solution is based on a mediation framework to be placed on top of the data sources. This framework will be in charge of solving the problem of having different data structures and naming. Also, when a new device connects to the mediator, the device will promote its capabilities that

will be taken into consideration when returning the data. Therefore, our framework is capable of handling heterogeneous data source and delivering data in different presentation.

2 RELATED WORKS

Designing the content of M-government services is a remarkable research area. In [3], the authors proposed a framework to understand mobile technologies and their implications for M-government applications as shown in Figure 2.

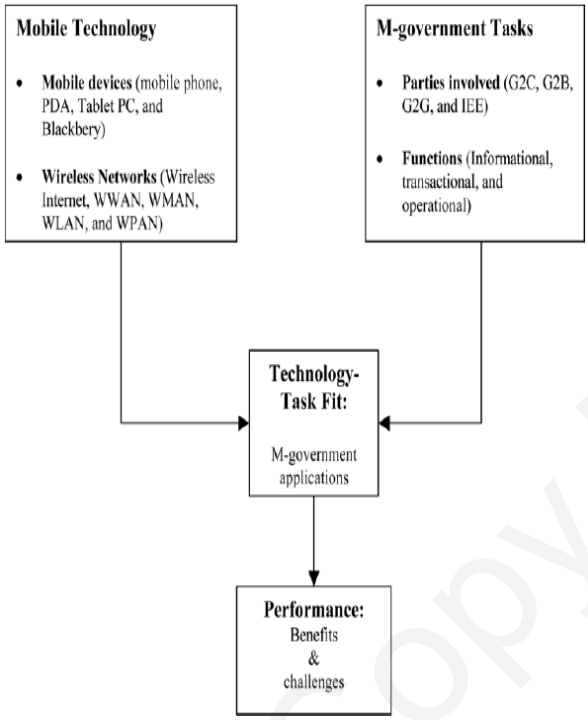

Figure 2: A Framework for Understanding M-government [3]

According to the framework the authors analyzed M-government applications and evaluated the mobile technologies (MTs) that are used in M-government. They have also categorized E-government services that can be provided through these technologies. Furthermore, the authors discussed the benefits and challenges of M-government in order to measure the degree of fit between MTs and government tasks and services performed through them.

In [9], the authors discussed some technical and policy consideration related to M-government. One of the important issues that were described in this paper is the content and presentation management. The authors suggested some useful guidelines to handle this issue such as: utilizing Content Management Systems (CMS) to add a formal structure to the content and to adopt enterprise-wide web and content design standards, using the Extensible Markup Language (XML), Extensible Style sheet Language (XSL), and employing Simple Object Access Protocol (SOAP) technology.

Another interesting research in M-government adaptation is presented in [1]. The authors examined location awareness and personalization techniques to ensure the importance in delivering the right service to the right users. The authors also proposed *a* logical architecture for governmental location based services which improved the creation of Intelligent M-government Services that match the best option of a service to the targeted user. The architecture includes four main components, they are: content server, application server, gateway and mobile location center.

In [8], the author proposed a systematic approach that allocates more M-government applications services from a user centric view by examining possible user needs within a set of possibilities and requirements such as the user role, processes of government organization and the context of use. The author discussed the three dimensions of mobility which are spatial, temporal, and contextual mobility. Furthermore, the research assessed the service mobility of M-government applications. In addition, the author describe three main stages to meet the user needs such as, examining the user readiness to use a certain technological innovation, followed by the determination of the user willingness to do so, and collecting user requirement to be considered while defining new M-government applications.

Different mediation frameworks have been proposed such as [11, 12, 13, 14, 19] to deploy as a middleware to resolve heterogeneous data sources integration. In general, this middleware is deployed on top of heterogeneous data sources and provides services to application deployed on the top of the mediator.

3. M-GOVERNMNET

To understand what M-government stands for, we are going to describe two fundamental terms: *"mobile"* and *"Government"*. We prefer to begin with defining the government since it is the base for the new applications that emerged recently, such as E-government and M-government. A government is the dynamic assortment of goals, structures, services, and functions by which a

community is ruled [7]. Government has a responsibility to enhance the provision of its services by utilizing different means and communication channels in order to improve the quality of the public service delivery.

The second term *"mobile"* is a key aspect that differentiates M-government from E-government and any other developments in the governmental sector that use new technologies [4]. It refers to two main components; first, the mobility of users that can acquire the public services anytime, anywhere and while they are moving; second, the mobility of technologies that are utilized in M-government such as mobile and handheld wireless devices.

In this work we define M-government as the flexible provision of public services through mobile and wireless technologies to support users anytime and anywhere.

3.1 FROM E-GOVERNMENT TO M-GOVERNMENT

In the past few years we have observed a rapid evolution of wireless technologies and a widespread of internet-enabled mobile devices. In the mid of 2005, the number of cellular phones per person, were more three times than PCs, and most of sophisticated phones have the processing power of a mid-1990s PC, and it is increasing [2]. In 2006 about one billion people, worldwide, purchased a new handset [5]. As a result, the number of mobile users increased rapidly and nowadays they are estimated to be 2 billion users.

Beside, the advancements in wireless technologies play a major role in escalating the number worldwide mobile Internet subscribers who have a wireless access to various online recourses through mobile devices as shown in Figure 3 [24].

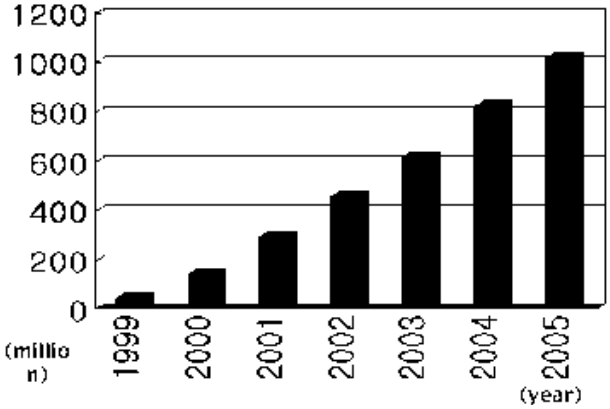

Figure 3: The Number of Mobile Internet Subscribers [24]

Such indicators revealed the importance of moving from E-government to M-government and they can be considered as the driving forces toward the adoption of M-government.

3.2 M-GOVERNMENT FUNCTIONS

In [6], the authors classified the M-government practices into three classifications which are: informational, transactional and operational functions.

Informational functions are one way transmission of information from government to the user. These functions provide governmental information via publishing and broadcasting. It can also send alerts and notifications to the user through SMS or e-mails. Transactional functions are two way transmissions of information from government to the user and vice versa. This class of functions allows the user to interact with the M-government system, such as online procurement and payments. Operational functions aim to handle the internal governmental operations. It enable government employees to access some important information from remote locations through their mobile devices.

However, in this work we are focusing on the content of the informational and operational functions and how this content must be personalized and adapted to meet the user preferences, location and technologies.

3.3 TECHNOLOGIES USED IN M-GOVERNMENT

3.3.1 MOBILE DEVICES

Devices that can be used in M-government must attain two key requirements which are: the ability to deliver the governmental services and the ability to support the user mobility. According to these requirements, mobile devices can be the best technologies that can be used in M-government.

Generally, mobile devices can be any device that is small, autonomous, and unobtrusive enough to accompany us in every moment of our every-day life [10]. Mobile devices can be categorized into main three categories as following:

- Personal Digital Assistant (PDA): PDAs are small handheld devices which have some of the personal computers capabilities as well as telephone capabilities. PDAs offer many interesting functionalities such as: organizing personal schedules, multimedia support,

recognizing text and voice input and they offer the user the ability to connect the Internet to check an e-mail or to search the web. PDAs have 64 Mb of memory size, 8 hours power capacity and 240x 320 pixel screen resolution as typical parameters. These devices run on two important operating systems which are Windows-mobile from Microsoft and Symbian operating system [9].

- Cellular Phones: In the last few years, cellular phones scattered all over the world. Cellular phones range from devices with limited functionalities that are used for voice and short text message communications to advanced devices, third generation phones (3G), that enable the user to connect to the Internet to send or check e-mails and to open small web pages. However, cell phones have 10 hours power capacity and up to 800x480 pixel screen resolution. For that, the flexibility of these devices is less than the flexibility of PDAs[9].

- Smartphones: SmartPhones are hybrid devices that take some abilities from PDAs and other abilities from cellular phones. Smartphones can be used for text and voice communication, e-mail, web access and media or video player. These devices have 10 hours power capacity, up to 800x480 pixel screen resolution and they run on different operating systems such as: Symbian, Palm, Blackberry and Windows Mobile.

3.3.2 WEB BROWSING ON MOBILE DEVICES

Although most of mobile devices nowadays are powerful, browsing using them is a research issue. Scaling down images or tables may affect the required detail quality. Moreover, sometimes these kinds of details may not fit the mobile screen. Most of web site designers do not consider browsing on move using mobile device; therefore, contents of web site need to be narrowed to fit small displays [22].

Mobile browsing is based on the Wireless Application Protocol (WAP). WAP is a protocol that was designed to allow the users to browse the Internet from their mobile device rather than browsing the Internet from a desktop computer. Moreover, this protocol can view the information that is written by Wireless Markup Language (WML).

Usually, pages that are displayed on mobile devices screen are different from those are displayed using PC browsers. Pages need to be reformatted to narrow and tall view to fit small displays. This reformatting technique may affect the order of presenting the content [23].

3.3.3 HETEROGENEOUS DATA SOURCES AND SECURITY ISSUES

Usually, data sources are distributed and heterogeneous that their structures and naming are different. Also, each organization applies different role of access to their data. In order to manipulate those sources efficiently, data must be homogenized to solve all naming and structures differences.

Many mediation architectures have been proposed in the last decade [16، 13, 15, 17, 14, 18, 12, 11]. All of these architectures aim to integrate heterogeneous data sources and present results to a higher layer on the top of a mediation. However, there are three main differences among mediation architectures. First, they are different in work distribution among several layers in the mediation architecture. Some of the architectures delegate more works to the wrappers while others design the wrapper to be as simple as possible. Secondly, the common data model used in communication between layers is different. While some architectures use an object-oriented model such as Garlic [17, 14, 18] or an object-oriented like model such as TSMMIS [16, 13, 15], others use semi-structured models such as MIX [12, 11]. Finally, the mediation architectures differ in the degree of centralization. For instance, some architectures maintain global schemas while others distribute the mediation schema over domain-specific mediators. The degree of schema distribution will not only affect the system's reliability, but also controls the integration process.

4. PROPOSED FRAMEWORK

As we have mentioned previously, M-government informational functions can provide end users with online published information and can send alerts and notifications to users while operational functions enable government employees to access any needed information from remote locations. In the following sections, we introduce our adaptive M-government framework based on mediation architecture and highlight some useful guidelines that must be applied in order to design information content, which is provided by the M-government platform, displayed efficiently and effectively.

4.1 ADAPTING MEDIATION ARCHITECTURE

We opt to choose a relaxed version of the 3-layer mediation architecture proposed by [19, 20, 21] (Figure 4). Integration layer will be simplified, since each query will be served by only one server and data sources are disjoined.

The nature of data is distributed. Because of breakthroughs in communication, it becomes feasible to access distributed data sources. Wireless telecommunication increases the users' desires to access data sources from wireless computing devices such as Personal Digital Assistant devices (PDAs). Unfortunately, in most cases, distributed data sources are heterogeneous in platforms, types, and structures. One of the solutions to integrate heterogeneous data sources is mediation.

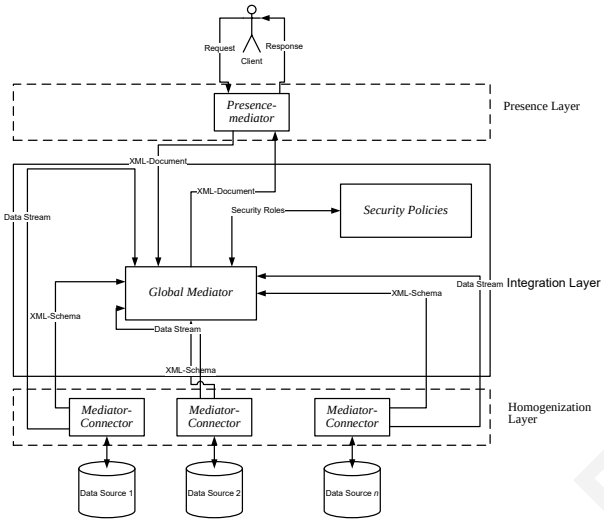

Figure 4: 3-Layer Mediation Architecture

The 3-layered architecture [20] designed by SSA at FIU is to define and build a multi-layered mediator-based multimedia architecture that provides a dynamic, scalable framework for telecommunications software environments. It is capable of handling complex data types and providing services to various devices including mobile devices. The architecture is based on three layers: a "presence" layer takes requests from clients and is responsible for the caching and buffering of streams that it receives from the "integration" and "homogenization" layers. Also, the presence layer is responsible for formatting the delivered answered based on the device capabilities. The second layer is the "integration" layer, which is responsible for indexing the participated data sources and applying security roles before forwarding the request to the data sources. The third layer is the "homogenization" where a connection to actual data sources is established. The common data model in the architecture is based on XML. XML is a semi-structured model that is capable of handling structured and unstructured data.

4.2 ADAPTING CONTENT PRESENTATION

Content adaptation which will be responsibility of the presence layer is a key part in the process of designing M-government applications. In other words, we have to adapt the content presentation to meet the user preferences and the different capabilities and limitations of mobile devices and wireless technologies that are used by different users. Thus, to adapt the presentation of the M-government content we have to take into consideration four main contexts which are: personal context, mobile device context, connectivity context and location context (Figure 5).

Personal context includes any information that is used to describe the user personal matters such as name, gender, date of birth and his service and content preferences. These information be used in the global mediation which is deployed in the integration layer o f the mediator to check the user access role before forwarding the request to a connector on the top of the destination data source.

The device context is any information that is used to characterize the user mobile device. It is a crucial issue to specify the user device capabilities in M-government application because they can have a big impact on what content is appropriate and meaningful to be delivered to the user. Some of parameters that characterize mobile devices are the main factors that will be used to characterize this context such as device type and device screen resolution.

Nowadays mobile devices can be connected to Internet through different wireless technologies. Each of them has different data transfer rate. As a result, we have to specify the type of wireless technology that will be used by the user to connect his device to the Internet and this is called the connectivity context.

Users with mobile devices may need some kind of information related to their location such as the nearest hospital, police station or any other information. Therefore, the location context will include any information that describes the user location.

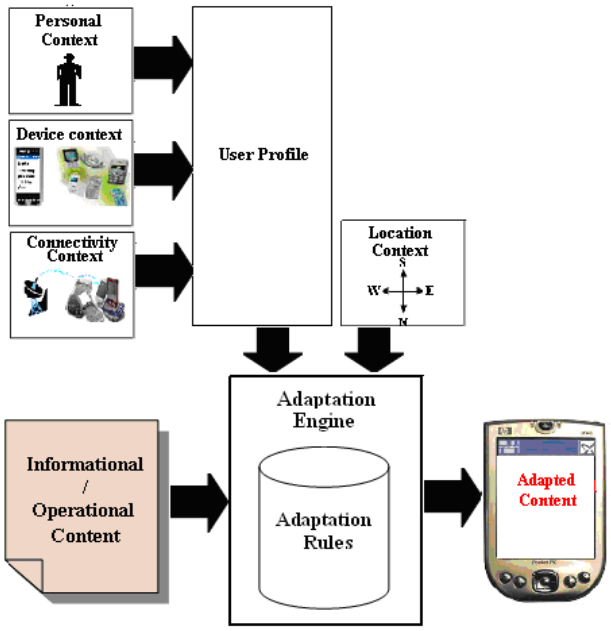

Figure 5: Adaptive M-government Content Framework

As shown in Figure 5, our adaptive model takes into account several factors from four context categories as discussed previously. The values of factors that are almost stable will be saved at the user profile and they will be used as inputs on the adaptation engine. None of the location context factors will be included in the user profile since all of their values regularly change. Finally, the adaptation engine specifies which presentation type is most appropriate to the user according to predefined set of rules. As a result, each user can receive an adaptive content that meet his preferences and is compatible with his mobile device and wireless technology. The following list describes some good examples that clarify how the framework can perform in different scenarios:

- By analyzing the user profile based on the date of birth and user gender from the personal context, governmental health clinics can distribute personalized announcement to women older than 45 years to have a screening mammogram at the end of this month.

- A policeman can search a suspect criminal photo from his mobile device that is wirelessly connected to a remote database. According to our adaptive model the system will check the policeman profile to determine the user device type. If the device type equal to PDA, the image will be displayed to him in a resolution less than 240x320 pixels while if his device type is a cell phone the image should be less than 120x160 pixels.

- Some government services aim to develop public awareness about a specific issue, such as the negative impact of smoking. The content can be displayed as animation with different resolution to fit the user device screen. Moreover, according to the wireless connection that is used, the content can be displayed as text, audio or animation. For instance, if the user is connecting the internet through GPRS, he can receive animated content while if he was using WAP that have a lower data transfer rates he can not receive animated content because it will take a long time to be downloaded on his device.

Based on the previous model, the expected dialog between the user and the system is shown in Figure 6.

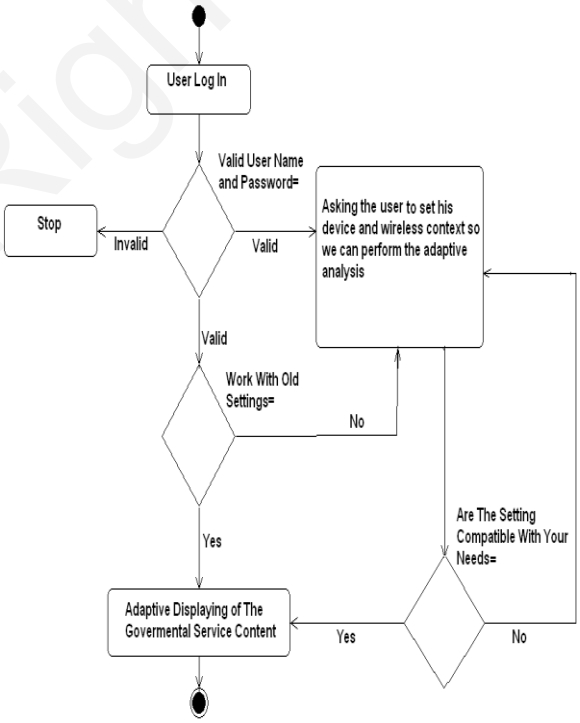

Figure 6: User and System Dialog

5. CONCLUSIONS

This paper proposed a framework that improves the provision of M-government services by delivering personalized and adapted service content to the appropriate user efficiently and effectively. The framework considers

different factors that characterize four contexts which are: the personal, device, connectivity and location contexts. The possible values for each factor will influence the content presentation type. We found that the same content must be found in different presentation types and in more than one resolution for graphical content, to fit different mobile devices and wireless technologies. Finally, the proposed framework is based on a mediation architecture that can handle heterogeneous data sources, apply different level of security, and adapt different presentation to the same data based on the capabilities of the connected user's device.

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