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UNIFIED M-GOVERNMENT APPLICATION BASED ON CLOUD-MEDIATOR ARCHITECTURE

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Abstract. *Nowadays, smart technologies such as smart mobile devices and cloud computing are widely used all over the world. Those devices have different capabilities, architectures, operating systems, in addition to different communication channels. Hence, M-Government application must adapt a framework that is capable of handling and presenting distributed data over heterogeneous systems, as a result of the differences among mobile devices and portable ones. This paper proposes a new framework, which is basically based on private cloud computing for adapting the content of the different services of the Mobile-Government (M-Government). The proposed framework has a 3-layer mediation architecture and an XML as semi-structure mediation language. Those 3-layers are divided into presence, integration and homogenization. The first layer, presence, involves the adoption of the content taking into consideration four contexts: device, personal, location, and connectivity contexts. The second layer, integration, is hosted by a private cloud server. Its main function is to integrate the heterogeneous data sources. The last layer, homogenization, is responsible for data conversion into XML format.*
Keywords: M-Government, Mediation, Data integration, Data adaptation

1. **Introduction.** These days, technology is considered as an essential tool that people use to perform their different day-to-day transactions. One of the important transactions is the governmental ones, which have an important effect in everybody's life. These transactions include follow up applications, query of records, submission of forms, etc. The received data is distributed over to the different units of the government using various applications. Such databases are heterogeneous in nature, structure and in naming of conventions.

Different ministries use websites, which are mostly informative ones, and applications. In most cases these applications support inquiry transactions. So, due to the lack of cooperation among the different units of the M-Government, there is need to design applications for mobiles that would handle both the interoperability and integration of these applications [1,2]. The proposed applications must be capable of handling differences in the governmental units and provide a unified view to users.

Users of technology devices prefer to use smartphones and PDAs, which have capabilities similar to the personal computers like an Internet connection and browsing. Smartphones and PDAs own further advantages such as various operating systems and capabilities. Advantages like different Internet connection speeds and screen resolutions [1] can support the design of new mobile application. All differences among various types of mobiles will affect both content presentation and usability [2]. Another major factor

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is the portability which encourages users to use technology, but other elements such as content presentation, integration and security are playing important roles in this respect.

Recently, there was an increase in high-speed communication infrastructures, and computer services, which plays an important effect on users' decision to adopt this technology [1,3,4]. This enabled organizations to host data on cloud computing database servers. Cloud computing has multiple advantages such as the ability to store large quantities of data, the fast query processing and the high degree of availability. One more advantage is the low cost of an initial acquisition on cloud computing, if compared to a self-hosted data management. This hosting service allows organizations to invest their money and resources on other expertise fields, rather than on information technology. On the other hand, other factors play a significant role on limiting the use of these systems, such as trust issues among owners, data users and cloud data storage service providers.

In this research, we propose a framework for handling the two aforementioned problems: accessing heterogeneous data sources and manipulating different presentations for mobile devices via the use of cloud computing. A cloud mediation framework is suggested as a solution, which is placed on the top of data sources and using private cloud computing. The main function of this framework is to solve problems of the different data structures and naming. Besides, when a new device connects with the mediator, its capabilities are going to be promoted and consequently will be taken into considerations when data is requested. Therefore, the framework is capable to handle any heterogeneous data source and to deliver data in different formats.

This research is organized as follows. Section 2 presents some related works, and Section 3 describes M-Government as well as the differences between E-Government and M-Government. In Section 4 the mediation framework is proposed, and a conclusion is driven by noting some features which can be added to the framework.

2. **Related Work.**

Recently, the purpose of developing M-Government is not limited to automate the government processes, but it is also to enhance the services. This is the goal that many countries and researchers invested in, and it can be attained through adopting new technologies, such as portable devices and communication technologies [1,2]. Sheng and Trimi [5] explained the main challenges and the needed technologies which may affect adopting an M-Government. The researchers discussed the applications of the M-Government, and they made an evaluation of the Mobile Technologies (MTs) that are used in M-Government. The mediation framework, proposed in this research, merges data from heterogeneous resources, and shows the content on multiple devices. The goal is to enhance both the services presented to the users, and to increase the usability of the M-Government.

Kumar and Sinha [6] proposed the idea of M-Government in some specific and related issues: technologies and policies, besides content and presentation management. They have introduced a Content Management System (CMS) to utilize the content. The framework adopted an enterprise-wide web and content design standards. It employed the following technologies: the eXtensible Markup Language (XML), eXtensible Stylesheet Language (XSL) and Simple Object Access Protocol (SOAP). Kumar and Sinha [6] framework handles the content presentation on websites. In our framework, XML technology is employed in mediator layers to get the advantages of the XML flexibility. Unlike the framework proposed by Kumar and Sinha [6], our framework is capable of integrating data from different data resources using 3-tier mediation architecture, in addition to handling the presentation of the content.

Another framework of M-Government was proposed by Al-khamayseh et al. [7]. This framework took into consideration two factors: the geographical location awareness and the personalization techniques as recommender systems, in order to ensure that the correct service is delivered to the right user. The architecture has four basic components: content

server, application server, gateway and mobile location center. It focused on informative messages delivery, that depends on location and personalized features while our framework is capable of handling informational, transactional and operational messages.

In order to resolve the integration of heterogeneous data sources, various mediation frameworks were suggested to be deployed as a middleware [8-13]. The middleware is deployed on top of heterogeneous data sources, which presents services to applications deployed on the top of the mediator. The mediator's basic role is to manage heterogeneous structures and then show the results to the client. Deploying the middleware will not affect the structure of the data sources. The middleware handles all the issues related to the differences in the structure of the data sources. Ege [14] proposed an example of an architecture, which employs a mediator and cloud technologies. This proposed architecture is a framework, which has a 3-layer mediator architecture. It is applied in an augmented reality presentation. There are many mediators which maintain each layer, and they are based on a cloud-server. When the cloud-mediator receives requests from a user, it compiles the data to build a life-like presentation. Like the framework proposed by Ege [14], our mediator is hosted by a private cloud.

3. M-Government.

Governments are looked upon as dynamic mixture of different features, such as goals, organizations, services and roles [15]. A government has basic duties, which are reflected in providing its functions and services in a better and improved manner. This can be attained through using various resources and communication channels to enhance the quality of delivering the services. Meanwhile, government strategies are going side by side with new government web and mobile applications, through developing the services into an electronic format.

The different services and functions which are provided by governments, via using mobile devices are gaining increased interest, which is based on user's mobility. Statistics shows that mobile devices can be reached more easily than any other technology. And in 2017, two thirds of the worldwide populace were mobile owners [16]. There are two key components that are related to mobility: first, mobility stands for the ability of users to use public services anytime, anywhere and on the go; second, mobility of equipment which the M-Government uses, as mobiles and tablet devices. In this paper, the authors discussed the M-Government in the form of flexible delivery of the public functions and services by using mobile devices and wireless technology.

When M-Government uses a mobile device, it must meet certain important requirements. These include, the capability to distribute the governmental services, and the capability to support the customer mobility. Based on such requirements, it is believed that smart phones and other mobile devices would be the perfect tools in M-Government. We use the expression of a mobile device to refer to any device that has small size, autonomous and unobtrusive, which can help the user in everyday life [17].

3.1. M-Government services.

Norris and Moon [18] divided the services of the M-Government to three categories: informational, transactional and operational. Below is an illustration of the function of each category. The first category is the informational service which is one-way communication to broadcast messages to users. The service also involves sending alerts and warnings to the users via SMS [19], e-mails or push notifications [20]. The second category is the transactional service that is two-way communication in which the government and the users send and/or receive information. In this category, the users are permitted to interact with the various organizations of the government, like online procurements and payments. The last category is the operational service which focuses on the internal governmental processes. This paper focuses on the content of both the informational and operational services, then it emphasizes the content of these two

services. The study also explains the different ways to modify and adopt the content, in order to fulfill users' different preferences, locations and technologies.

3.2. **M-Government heterogeneous data sources.** The governmental data sources are distributed over many ministries and departments. Each ministry uses its own information system, and some ministries maintain different information systems, one to each department. As a result, the data are heterogeneous in that their structures and naming are different. Also, each organization applies different roles of access to their data. In order to manipulate those sources efficiently, data must be homogenized to solve all naming and structure differences.

Many mediation architectures have been proposed in the two last decades [8-11,21-25]. All of these architectures aim to integrate heterogeneous data sources and present results to a higher layer of 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 work 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 project [11,24,25], or an object-oriented like model such as The Stanford-IBM Manager of Multiple Information Sources (TSIMMIS) [22,23], others use semi-structured models such as Mediation of Information using XML (MIX) [8,9,12]. 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 will also control the integration process.

4. **Proposed Framework.** The previously mentioned functions of the M-Government are enhanced through the use of a single mobile application. That mobile application sends the stakeholders with online-requested information and sends alerts as well as notifications to the users. The proposed framework introduces a single application, that has the accessibility to various services in different departments without transferring the real data to the mediator server. In the following sections, a mediation framework of the M-Government is proposed. Fan and Perros [26] introduced a framework, in which the cloud servers are distributed over many governmental sectors. Our mediation framework adapts the multi-cloud to manage the private-cloud mediator framework.

In this study, the authors have chosen a relaxed version of the proposed 3-layer mediation architecture [12,21,27] (Figure 1). At the level of integration layer, it will be simplified, because in this architecture form, the query will only be served by one server hosted in the private-cloud, since the data sources are disjoined. Therefore, there is no need to implement the Distributed Hash Tables (DHTs) in the relaxed version of the framework. This 3-layer mediator-based architecture provides a dynamic and scalable framework for telecommunication software environments. Since the proposed architecture uses XML, then it can manage several data types. Its construction is based on three layers. A presence layer is responsible for receiving the requests from customers that use the M-Government application. It is also responsible for caching and buffering the streams, which are sent from the integration and homogenization layers. Besides that, the presence layer is responsible for adapting the delivered data into forms, according to the capabilities of the device. The second is the integration layer, and it is responsible for the process of indexing the participated data sources. Besides, its function is to apply security roles prior forwarding the request to the data sources, in addition to negotiating among the heterogeneous naming and data types. This layer also supports the global schema, which is an XML formatted file and maintains the connector data, to help in

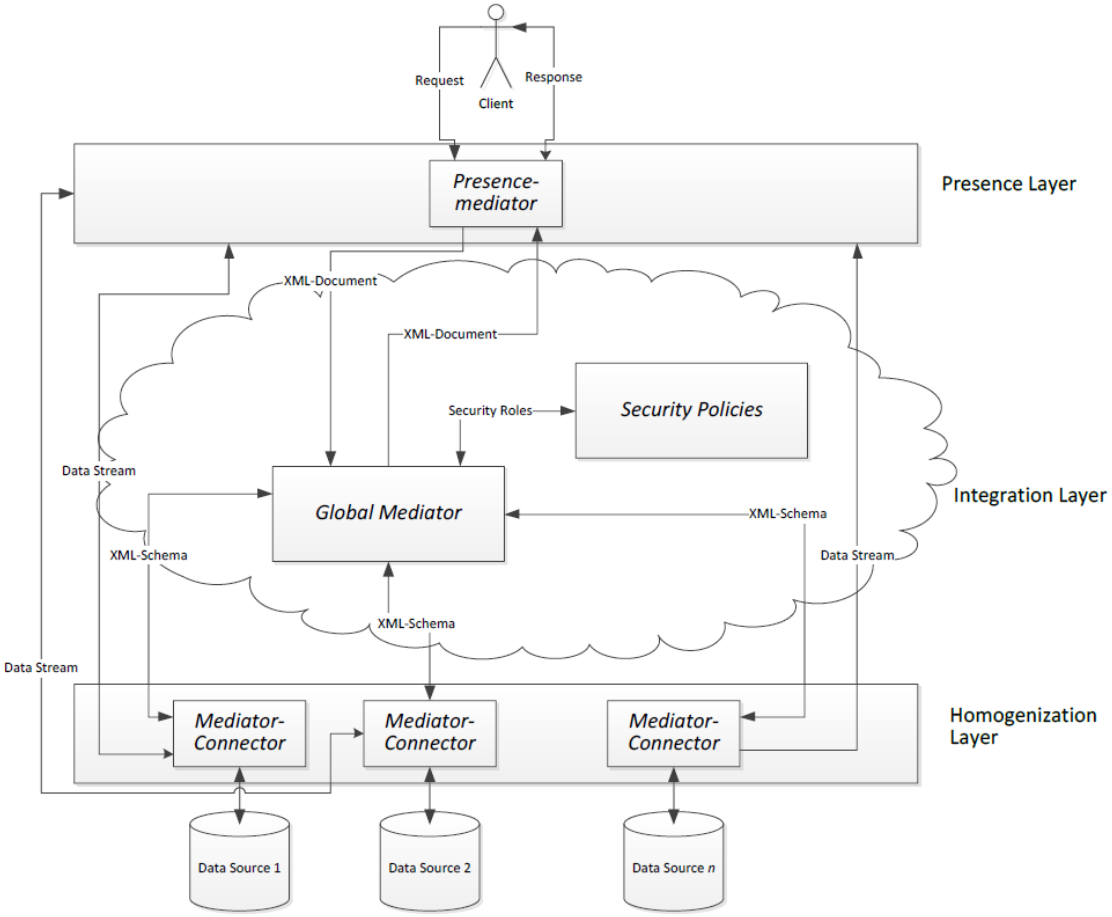

FIGURE 1. 3-Layer mediation architecture

solving the naming convention in several sources. The third is the homogenization layer. It establishes a connection to the actual data sources, then it converts data into an XML file to be sent to the presence layer to format the received data according to the device capabilities.

The connector is at the top of each data source in the system. Any new data source joins the system by adding a new connector to the system. This new connector sends the XML of its data source to the integration layer in order to promote its source. The integration layer sends a request in XML format to the connector, when it requires data from the source. As the connector receives and accesses the data source, it sends back an answer to the integration layer or the presence layer in XML format.

Adapting content presentation. The presence layer is responsible of the content adaptation, and it is a key part in M-Government applications design [28]. At the presence layer, an XML file is received and includes the data which will be presented to the user. This layer adapts data in the receiving contents based on the settings in the application of the device at which it is installed. The settings include mobile device context, personal context, connectivity context and location context.

At the personal context, it includes the demographic and personal information that describes user's name, gender, date of birth, role and content preferences. The personal information is used in global mediation, its function in the integration layer is to check user's access role, then to forward the request to a connector on top of the destination data. The main aim is to stream data to the presence layer. Whenever there is an error with user's privileges, it is returned to the presence layer and not connected to the data connectors.

At device context attributes, user's device features are presented. The purpose of identifying the different capabilities of the devices at the presence layer is to be able to deliver and use data in the M-Government application in a meaningful and appropriate manner. For instance, to be familiar with the screen size of the device, and the resolution can have big effect on data presentation.

In regard to the mobile devices, there are two important issues, and they are Internet connection and location services. To connect a mobile device to Internet, it means to do so through 3G+ or wireless. The presence layer pays attention to the quality of the Internet connection, which is called the connectivity context. Mobile applications can locate user's mobile location by using Global Position Services (GPS) or 3G+. And based on this, the application can send or receive notifications related to the location. For example, users can use the application to find the closest police station or hospital. This feature is called context services.

This framework has various features. Some of the features include the adaptation of a content based on the setting in the different mentioned contexts: mobile device context, personal context and connectivity context. The integration layer preserves the value of such categories, and it manages the profile of the user and the mapping schema among the distributed data sources. Since the location context changes frequently, it is maintained by the presence layer.

Informative messages are sent according to certain personal (demographic) values. For example, let us suppose that there was a health event, held by the ministry of health. It is about a free screening mammogram, so, the messages will be sent to users based on two factors: age and gender. Using the push messaging system, a notification can be sent to lower the cost and raise the efficiency [22].

5. **Conclusions.** In this study, an adaptive content framework is constructed based on a three-tier mediation architecture and private cloud. It is introduced to integrate and enhance the different services of the M-Government using a unified mobile application. The three tiers of the mediator are presence, integration, and homogenization. The presence layer is responsible for handling request from users to forward it to the integration layer and present the results to the user. Integration layer maintains the global schema which is a map to the data sources and maintains the access roles. Homogenization layer maintains the connector mediator which converts the data source into XML document and manages data access from the source.

Besides, four contexts are designed in the framework, and they are the personal (demographic) context, device context, connectivity context and location context. Whereas the first three contexts deal with adaptation and presentation of the data, location context does not affect the presentation. The location context is also used to filter informative messages, and usually does not affect the presentation.

The proposed framework is basically designed on a mediation architecture, which can handle heterogeneous data sources, implement various levels of security, in addition to adapting different presentations of the same data, taking into consideration the capabilities of user's connected device.

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