A Conceptual SOA-Based Framework for e-Government Central Database

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Abstract— **The Central Database is one of the core components in the Palestinian e-Government technical framework. The Central Database model lacks features such as: interoperability, flexibility, and manageability. The purpose of this paper is to propose a SOA based solution for the Central Database that achieves the above features.**

Keywords: e-Government; SOA; ESB; Central Database; Database Replication; Web Services

I. INTRODUCTION

E-Government has drawn increasing attention recently; it represents a promising initiative that makes people's life easier [14]. The ultimate goal of the e-Government is to improve government–citizen interactions through an infrastructure built around the "life experience" of citizens [9]. In the year of 2005 the Palestinian Government adopted the e-Government initiative by the Ministry of Telecom and IT (www.mtit.gov.ps). The technical framework for the e-Government was specified and one of the main components in the framework is the Central Database. The Central Database integrates different data sources replicated from various ministries and consolidates it in one location. The Central Database will be discussed in Section III.

Data integration between heterogeneous data sources raises three important different issues: flexibility, interoperability, and manageability. The flexibility requirement in data integration is primary demand since the requirement for the large number of participants in the data integration may vary both in terms of database and network connectivity. Interoperability is also required in order not to tight the Central Database to a specific database management system (DBMS) and hence the integration process will be independent of the platform or the DBMS type, and database accessibility accessed based on neutral mechanism and should be independent of the underlying implementation [5]. The manageability is a third requirement to be considered for the Central Database because different database systems are to be integrated into one database and various institutes require the issue of QoS and governance to be addressed because ministries databases are not under the control of one central authority.

The current Central Database model lacks the flexibility, interoperability, and manageability features. It is bound to a specific database type for replication and connectivity and a limited management capabilities for the database integration. The shortcomings of the Central Database model can be eliminated by transforming the current model into SOA architecture and realizing it using ESB. SOA provides a solution to shared and distributed services and it achieves high interoperability, flexibility, and standardization by utilizing the description, discovery, and invocation of services.

We propose the use of Web Services in the SOA architecture. Using Web Services in e-government enables government institutes to provide additional services by defining a new service that emerges from other e-government services [9]. To realize the concept of SOA model, one would use the Enterprise Service Bus [11][12]. The ESB will act as the middleware glue infrastructure that holds an SOA together and integrates and manages the communication between different Web Services [10], applications, and data sources and will provide functionalities such as routing and transporting service requests, security assurance, service orchestration, and management capabilities. The three parts Web Services, SOA, and ESB will be a basis for realizing the e-Government Central Database framework.

The rest of the paper is composed of the following sections: Section II presents related works and the application of SOA in similar domains. Section III addresses and analyzes both the current e-Government technical framework and the Central Database model. Section IV presents the proposed SOA-based framework of the Central Database. Section V addresses the conclusion and future work.

II. RELATED WORKS

SOA has been used in e-Government to achieve objectives such as application and data integration. [2] proposed introducing the concept of SOA in e-Government through the use of Web registry based on ebXML or UDDI. The suggested registry can be used to enhance interoperability of information exchange between governmental institutions.

[13] proposed a technical concept that employs a SOA as an IT platform and ecosystem to handle different modalities, devices, and data streams in the operation room. They proposed SOA for networked medical devices and integrating legacy medical devices in this network.

[7] proposed a model for a service-oriented e-Government support platform for the integration of application and data known as (SoGoSP), the proposed model is able to effectively integrate applications and data from various business systems deployed in e-Government external networks and e-Government internal networks. The model consists of four layers, which include service integration layer, service support layer, common service layer and application layer.

[4] presented a solution to data integration problem between heterogeneous databases. The solution is based on constructing data center with Web Service technique and XML schema which can give a good solution to problems with business logic method invocation and transparent data exchange in low layer.

[14] addressed the requirements of integrating multiple heterogeneous information management systems in the e-Government information technology by introducing an architecture of e-Government information management platform based on SOA framework. Their proposed system is based on service components extracted from Government Resource Planning and is based on J2EE and ESB.

III. PALESTINIAN E-GOVERNMENT AND CENTRAL DATABASE MODEL

The current Palestinian e-Government technical framework is presented which is composed of four layers: front-end access layer, common services layer, data access layer, and infrastructure layer. The Central Database model is the second part to be presented in this section, which is one of the core components in the e-government technical framework.

A. e-Government Technical Framework.

The current adopted Palestinian e-Government technical framework addressed by [8] and adopted by the Ministry of Telecom and IT (www.mtit.gov.ps) has four layers with different components that need to be realized in order to have a fully functional e-Government.
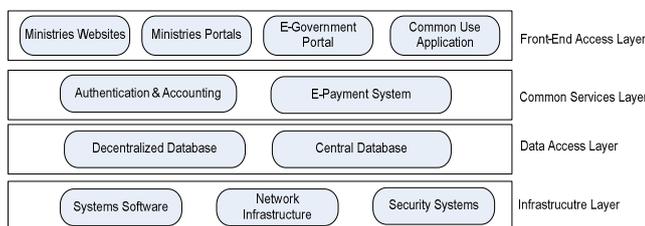

Figure 1. e-Government Technical Framework

Fig. 1 depicts the e-Government technical framework and its main layers. The Central Database is one of the components that lie in the Data Access layer of the e-

Government framework. The importance of having such component emerges from the fact that e-Government processes and services heavily involve and require exchange of data between different government institutions.

The e-Government framework is composed of four layers. The front end user interface layer, the common service layer, data access layer, and the infrastructure layer.
1) *Front-End Access Layer* presents the access interface that the end user interacts with. It includes applications such as e-Government portal, ministries Websites as well as ministries applications.
2) *Common Services layer* provides front end services that commonly needed by e-Services, such as authentication and e-Payment services.
3) *Data Access layer* addresses database access gateway, either centralized or decentralized. Front end services rely heavily on this layer. For example, online job submission service requires access to data from different sources, which turn to be in the Central Database. We further elaborate on this layer in Section III.B.
4) Infrastructure layer: This layer includes physical and low level software components, such as government private network, operating system and services, and security systems.

The overall e-Government technical framework is not fully implemented and parts of it still need to be realized. Also the communication between layers is not well defined in terms of access protocols and standards.

B. The Current Central Database Model Pros and Cons

The database access layer comprises both centralized database and decentralized databases. In decentralized databases every ministry uses its own database for its own business and it has full control over the database. The Central Database comes as a solution to sharing and integrating data between various ministries. The focus in this paper is on the Central Database in the Data Access layer (Fig. 1). Fig. 2 depicts the current implemented Central Database model which is approved by the Palestinian Government Data Integration Committee (www.takamul.gov.ps)
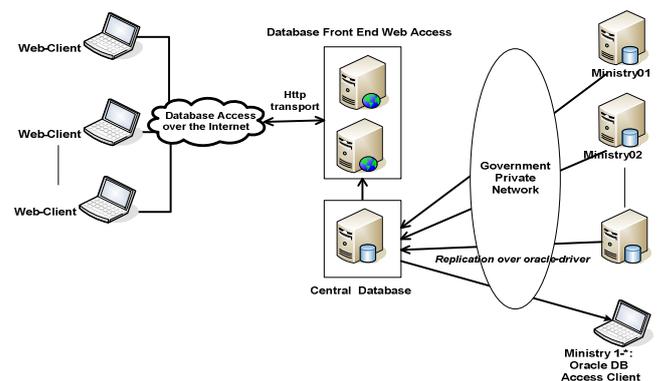

Figure 2. Current Central Database Model

The Central Database can be thought of as a broker that integrates data from different sources and then allows the

exchange of data between partner ministries through it. The current model for the Central Database relies on database replication and synchronization techniques as the low level infrastructure to maintain the Central Database and to keep its content up to date.

The main characteristics of this model can be classified into three categories which are:

1) Database Access :
   - The Central Database access mode is read-only for ministries use, since it has a one-way replica for ministries databases, the writing to the database is done at each ministry that owns the data.
   - Direct access to Central Database is allowed from government private network, and requires Oracle connectivity API
   - No direct access to the Central Database from the Internet which is classified as un-trusted zone.
   - Client access to the Central Database is realized through calling Oracle procedures, with predefined parameters.

2) Database Replication:
   - The Central Database operator has read-only access to each ministry's database that is replicated to the Central Database.
   - Replication between ministries and Central Database is achieved using Oracle utilities and tools such as materialized views and database links.

3) Management and monitoring:
   - Monitoring the Central Database is performed based on database parameters, and the monitoring system is not a proactive one.
   - Governance issues are limited to managing the main functionalities of the database access.
   - Security policies are implemented at both network and database access level.

The above mentioned characteristics do not impose clear constraint on using SOA solution in the Central Database. There are no old fashioned legacy applications or rigid connectivity access mode to the used database, which make SOA a suitable framework for realizing the Central Database model.

The current Central Database model is being criticized for the various limitations. Some of them are listed below:

1) Replication between Central Database and ministries databases can only be achieved between Oracle type databases. This imposes inflexibility on database usage and tights ministries to using proprietary commercial based specific database type.

2) Access to the Central Database is restricted to oracle connectivity API, which decreases the level of interoperability.

3) Direct access to database procedures is achieved only with government private network and through oracle standard sql port, which undermines the flexibility and accessibility.

4) Central Database has a read-only access mode which undermines the capabilities of the database.

5) There is no standard way for the description, finding and invoking the procedures defined in the Central Database to be accessed by its clients, which leads to less flexibility and more management overhead.

6) System monitoring, management and security assurance is built on oracle database itself.

The above mentioned limitations undermine the flexibility, interoperability, scalability, manageability, and governance of the Central Database, such features can be achieved if we adopt SOA solution.

IV.   THE PROPOSED SOA FRAMEWORK FOR PALESTINIAN E-GOVERNMENT CENTRAL DATABASE

The proposed SOA-based Central Database model relies on SOA solution. The reason behind proposing to adopt SOA is because of its open architecture and platform standards that cope with heterogeneous systems in order to achieve high degree of scalability and flexibility. A typical architecture includes three main roles that interact using standard messaging. The roles are service provider, service registry and service client [11]. The service is first published by the service provider to the service registry, which is a repository that holds services interfacing information. The service client searches the service registry for a specific service, and gets its binding information. The client uses service binding information to consume the service provided by the service provider.

Web Service is used in SOA architecture. The fast adoption for Web Services emerged from the maturity of XML-based Web Service standards such as SOAP and WSDL [1]. To realize the concept of SOA and to achieve a suitable and manageable integration infrastructure for Web Services, the concept of the ESB should be introduced [12]. The ESB is the infrastructure that integrates the components of the SOA concept; it integrates the applications, services, and the registry. The ESB provides management and security functionality and enhances the QoS for the services provided by service providers linked to the ESB. The ESB is event driven and provides standard messaging between services, it routes and transports service requests to the appropriate service provider [6][11]. A typical ESB provides functions [3] such as: routing, message transformation, service mapping, service orchestration, transaction management, and security.

A. SOA-based Central Database Requirements

The requirements for the Central Database need to be defined ahead before presenting the proposed model. To overcome the shortcomings of the current model as mentioned in Section III.B, the requirements are specified as follows:
   - Accessibility Mode: The Central Database accessibility should be based on standard connectivity rather than proprietary commercial software access mode, such standards are XML, SOAP and WSDL.

- Replication: Government ministries need to replicate and synchronize heterogeneous database type such as: Oracle, mysql, MS-SQL, MS-Access, with the Central Database. Hence different replication options should be provided for the diverse types of used databases.

- Governance: The Central Database should be governed through QoS and Service Level Agreement (SLA) to provide interactive eServices.

- Management and Monitoring: Monitoring and management should be separated from the application logic and database procedures access. Logging and performance metric recording should be implemented.

- Security: Security should be managed centrally and imposed on all database accesses. Security policies must be defined and enforced.

- Reachability: The access should be allowed through the government private network as well as the Internet.

B. SOA-based Central Database Structure

To realize the requirements discussed in Section IV.A for the proposed SOA-based framework of the Central Database, different components are presented that constitute the proposed framework. Each component satisfies one or more of the requirements and hence collectively leads to the achievement of the goals of the framework. The framework which is based on Web Services, SOA, and ESB is depicted in Fig. 3.
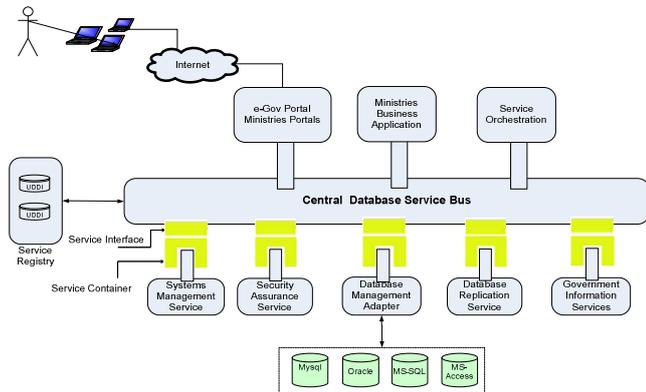

Figure 3. Proposed SOA-based Central Database Framework

1) *Central Database Service Bus* is considered the central platform of integration between different Web Services and provides routing and transportation features for Web Service requests, as well QoS feature for the framework. It will be accessed by government institutes via a private network and by non-government institutes over the Internet for.

2) *Service Registry* is used to provide a search point of access to services and database definitions and metadata for all services provided by Central Database model. This registry will be based on UDDI.

3) *Government Informational Service* provides access to basic informational queries. For example, Web Service that

returns social information of a citizen, or employee administrative record.

4) *Service Orchestration* ss responsible for managing composite services. The composite service is invoked by the client and it in turn invokes and orchestrates different services to achieve the requirement of the composite service.

5) *Database Management Adapter* allows the Central Database Service Bus to accept requests for data source from client systems then invoke the relevant adapter to retrieve the data and return it in a standard format to the requester. This component will accomplish the accessibility requirement.

6) *Database Replication Service* is used to manage replication between the Central Database and ministries databases, connections types, mode of replications, access permission, etc. are addressed by this service. This service is responsible for achieving the replication requirement.

7) *Systems Management Service* is used to manage and monitor the Central Database service bus, and Web Services. It will collect metrics and provide framework performance reporting capabilities. Both governance and management requirements of the framework are achieved through this service.

8) Security Assurance Service: This service will insure that security policies are adhered to and will achieve the security requirement in the framework. It will be invoked by different services to add security layer to their functionality. Security functionalities provided are: authentication, authorization, and non-repudiation. This service would carry out the security requirement of the framework.

The interaction between the components is done through the Central Database Service Bus, which will integrate the components and will act as the glue that tight them together, it will route, transport, and format the requests and response of the services, it will and will also provide service discovery through the registry.

This framework achieves its goals which are interoperability, flexibility, and manageability. The interoperability, which allows using diverse type of database, is achieved by having different database types as part of this system and can be part of the replication as well as resource for different governmental information services. The flexibility, which allows different ways for performing a specific task, is achieved by accessing the information services over http transport which generally uses the port 80 which is normally not filtered by internet firewalls, and hence the access to the Central Database can be both from internal government private network as well as over the Internet. The manageability which provides the ability to control and adjust the behavior of the system in response to various circumstances is accomplished by having metric, performance, and QoS in the management services.

C. Usage Scenario

To further illustrate the idea presented in this section, Fig. 4 depicts a usage scenario of the framework. Suppose a citizen

would like to check his social status in the Citizen Population Registry, for example, in order to verify that his new born baby was added to the social section of his identification card.

The citizen, over the Internet, accesses the citizen information section of e-Government portal using his login credential. The Web application running at the portal would use SOAP messaging and transport to invoke ,say, the *Citizen Information Operation* which is part of the *Government Information Services*. The *Government Information Services* would then interact with the *Security Assurance Service* to make sure security policies are not violated and access for this context is allowed. The *Government Information Service* would then invoke the *Database Management Adapter Service* which accesses the Central Database over the appropriate database driver and returns the response to the *Government Information Service*. This service processes the results and returns them back to the Web application at the e-Government portal. Finally the Web application presents the required information to the citizen.
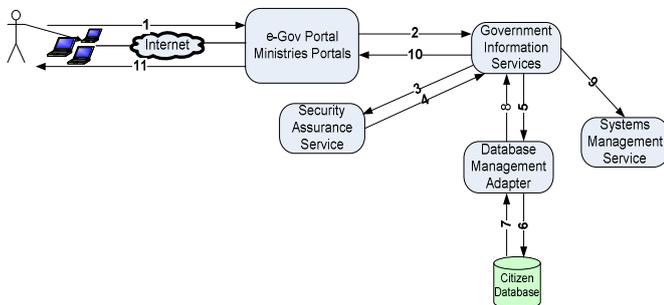

Figure 4. Usage Scenario for the proposed framework

The presented scenario outlines how the proposed framework achieves interoperability and flexibility. First, flexibility is achieved by using standard http transport to carry messages between the Web application in e-Government portal and the *Government Information Services* (either over the government private network or the Internet)*;* the http transport is generally allowed and not filtered by firewalls; where in the current model of Central Database such access would be carried over oracle-sql port which most of the time needs security reconfiguration to allow it, also the portal access to the Central Database is restricted to be from the government private network. Second, interoperability achievement is clear in this scenario, this is because the Web application and the *Government Information Services* are database type independent, and so if the low level database that holds the Citizens Population Registry is changed from e.g. oracle to mysql, then change is not required either to the Web application or to the *Government Information Services*.

V. CONCLUSION

In this paper the current Central Database model, a core part of the Palestinian e-Government technical framework, was presented and analyzed. A new Central Database model based on SOA solution is proposed that overcomes the shortcomings of the currently used model that lacks the interoperability, flexibility and manageability. The main contribution of this paper is to align SOA conceptual framework to the e-Government domain. Future research efforts can be directed towards the realization of the proposed framework and the challenges that face its realization, as well as to address an enhanced SOA framework that considers governance and policies of Web Services that are published by Central Database as well as local database services providers, both at the central and distributed database levels.

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