Chapter 31

A COTS-ORIENTED PROCESS FOR CONSTRUCTING ADAPTABLE E-GOVERNMENT SERVICES

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Abstract: As many governments the world over are engaged in an e-Race to provide their citizens, business communities and public organizations (i.e. service consumers) with electronic public service delivery (EPSD) information systems, the number and type of devices that can be used to access these services is increasing all the time. The mobility of the service consumers over a wide geographical range raises new essential user and system requirements for EPSD systems. Therefore, in order to address the needs of the "mobile citizen", this research proposes an infrastructure for developing EPSD systems that are designed to offer service consumers their individualized information or government services wherever they are, whatever time and whatever their connection point or access device used. In this approach, services are created by applications that are dynamically constructed and configured from a set of interconnected COTS-components with the service instances adapted to the access device used based on the context knowledge of the user, {*time, location, access device*} and the capability profile of the access channel. The systems are designed so as to cope with *dynamic* and *evolving system and user requirements*

Key words: e-government services, Commercial-Off-The-Shelf (COTS) software components, mobile citizen, Electronic Public Service Delivery (EPSD), access/delivery channels, dynamic and evolving system requirements, context knowledge, adaptable services, service consumer

1. INTRODUCTION

Citizens and business organizations of the developed nations currently live and operate in increasingly interconnected societies where the internet is used to get government services 24/7 (*i.e. 24 hours a day, 7 days a week*).

More than 60% of all internet users interact with government sites (Forman 2002). Many national governments the world over are currently engaged in ambitious, tight-scheduled e-Race initiatives. The US federal expenditure on IT exceeded $48 billion in 2002 and is expected to exceed $52 billion in 2003.

The main stated goal of all these governments' e-Race is to provide their citizens, business communities and government departments with an efficient and effective electronic service delivery mechanism. However, due to the scale and complexities of these systems, this new frontier will require novel and innovative rethinking of both the structure of the applications and the processes for developing those applications. This research therefore, proposes a flexible infrastructure for *constructing adaptable Electronic Public Service Delivery (EPSD) software systems by integrating multiple Commercial Off-the-Shelf (COTS) software components* that are can be procured *off-the-shelf* in the market. Specifically, this research proposes an infrastructure that dynamically integrates and configure on-demand, multiple COTS software components that are suitable for developing applications that provide e-services offered by the government..

The rest of the chapter is structured as follows: Section 2 provides a "normative" framework for e-government services; section 3 maps out the scale and complexity of providing e-government services. Section 4 gives a description of the proposed COTS-Oriented Process. The overall architecture of the proposed infrastructure is also provided in this section. Section 5 describes proposed profiles for profiling COTS software components and access devices. The chapter concludes with an outline and a vision for key future research directions that are necessary to put the proposed e-Race initiatives on the *e- track!*

2. A NORMATIVE FRAMEWORK FOR E-GOVERNMENT SERVICES STRATEGY

e-Government is the provision of services from government-to-citizen (G2C), government-to-business (G2B) and government-to-government (G2G), (Gouscos et al. 2001, von Hoffman, 1999), using *Electronic Public Service Delivery (EPSD) system over the internet.* In addition to services provided, e-government also brings best commercial practices to key government operations to bring internal efficiency and effectiveness (IEE) to government departments, (Forman, 2002). e-Government services portfolios can be summarized as shown in figure 1, below:

G2C * Use the web for accessing services such as benefits, loans, recreational sites and educational materials * **Key lines of business**: social services, taxes, recreation * **Key benefits**: will fulfill the vision of one-stop, online access to benefits and services; will also bring modern relationship management tools to improve the quality and efficiency of service delivery.	**G2B** * Reduce burden on businesses by adopting processes that enable collecting data once for multiple uses and streamlining redundant data * **Key lines of business:** regulation, economic development, trade, asset management, etc. * **Key benefits:** will reduce burden on businesses by adopting processes that reduce redundant data collection.
G2G * Share and integrate central, regional and local data * **Key lines of business**: economic development, public safety, law enforcement, transport, etc. * **Key benefits:** will enable the sharing and integration of central, regional and local data to facilitate better leverage of investments in IT systems (e.g. geographical information systems) and to provide better integration of key government operations such as disaster response.	**IEE** * Adopt commercial best practices in government operations – supply chain management, CRM, HR, work flow management, etc. * **Key lines of business**: supply chain management, HR, finance * **Key benefits:** brings commercial best practices to key government operations particularly supply chain management, financial management, knowledge management, CRM, etc.

Figure 1*: Summary of e-Government portfolios (synthesized from Forman 2002 and Gouscos et. al, 2001). A successful e-government strategy focuses on four citizen-centered groups each providing opportunities to transform delivery to government services:*

3. THE SCALE AND COMPLEXITY OF PROVIDING E-GOVERNMENT SERVICES

The development of electronic public service delivery systems is not easy. The services offered to service consumers (citizens, businesses, and government departments) need to be joined up and delivered through a range of channels and backed-up by a complex back-end software support system and communications network. Traditionally, private citizens and business organizations that need to deal with the government have a limited choice of channels for accessing government services. Using traditional methods, service consumers can only use a call center, write a letter to the government, phone the government department directly or visit the government office as depicted in figure 2 below.

However, with an EPSD system, users should be able to access the same government services *anytime, anywhere,* in the right format irregardless of the access method/device used as shown in Figure 3.

As mobility becomes a major paradigm of the future and lifestyle of tomorrow's citizens and businesses, the infinitely increasing choice of access devices and accompanying demands for instant government information and services are among the most challenges for developing EPSD systems. This

"*new frontier*" requires rethinking the structure of government electronic information systems applications and the way these systems need to be designed. Private citizens and business organizations will want to be able to access government services using any access device available or that suddenly becomes the "rage" wherever they are!

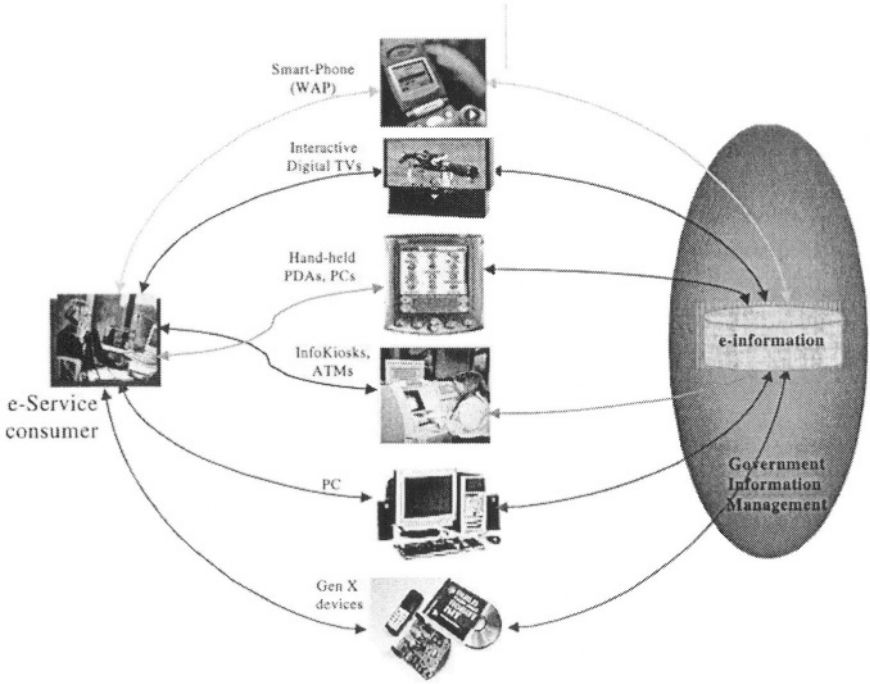

***Figure 2**: Traditional access methods. Users can either write a letter to the government, phone a call centre, visit a government officer or government department.*

The rational for EPSD is to envision a government so connected that everyone *–private citizens, business and government people* – can have computerized e-Personal Agents (e-Pa) updating them on almost anything or topics of their choice, wherever they are, whenever they want using any access channel of their choice (von Hoffman, 1999). This will allow private citizens and business organizations the ability to have their entire government on their screen, on the move, anywhere, anytime, whenever they want it. An EPSD system therefore should be designed to:

(a) give citizens access to all their records in an integrated and intuitive fashion, e.g.. *one-stop-shop;*

(b) ensure core consistency across services in the way information is defined, stored and presented, while accommodating uniqueness where appropriate *e.g. private citizen information, business information or government information;*

(c) design services to be independent of delivery channels, i.e. applications should be designed so as to cope with the latest changes on the delivery channels, *e.g. using the object-oriented paradigm*

(d) facilitate use by clients with special needs, *e.g. e-accessibility capabilities, text or screen magnifiers.*

A flexible infrastructure that aims to achieve the above objectives is described next.

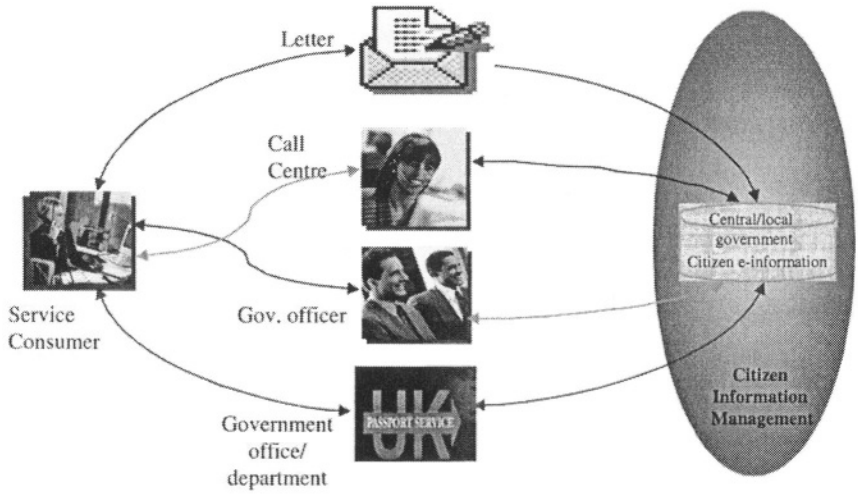

Figure 3: Electronic devices/channels for accessing government e-services

4. A COTS-ORIENTED PROCESS FOR ADAPTIVE E-GOVERNMENT SERVICES

As mentioned above, the mobility of service consumers over a wide geographical range raises new essential user and system requirements for EPSD systems. The number and types of devices that can be used to access government services is increasing significantly all the time (Marvie et.al 1998, Capra et. al. 2000). The use of access devices such as smart mobile phones, PDAs, public inforkiosks and PCs over a large-scale internet and WAP network means that EPSD systems should be designed such that are uniformly accessed. Furthermore, the information content and the system configuration should be relevant to the consumer's context such as *location, time and access device.* Therefore, a framework for building EPSD systems in such a way that a ***single service instance is adapted to the access device based on the user's context*** envisioned.

This research proposes a COTS-Oriented process for building adaptive e-services using COTS-software components. In this approach, an application is dynamically constructed, configured and then executed from a set of interconnected COTS-components with the service instances transformed, formatted, adapted and then routed to the access device based on the context of the user. Depending on the capabilities of the access device used, a single service instance will be created and adapted at the point-of-need, to the relevant access device capabilities, thereby providing the same service information whatever the user's connection point, access device and context.

To achieve this, a Service Oriented Middleware (SOM) infrastructure that will handle all the complexities is required. The SOM would provide service-transformation services and would be able to split, reformat and combine services to be delivered to any access channel. For this, predefined rules for forwarding reformatted services to the appropriate device are required. The service delivery is based on various conditions and the SOM utilize *situation rules* that are defined in the *rules inference engine, transformation rules* that are part of the *service transformation engine* and *routing rules* that are part of the intelligent *service routing engine.* Figure 4 below depicts the structure of the envisioned SOM.

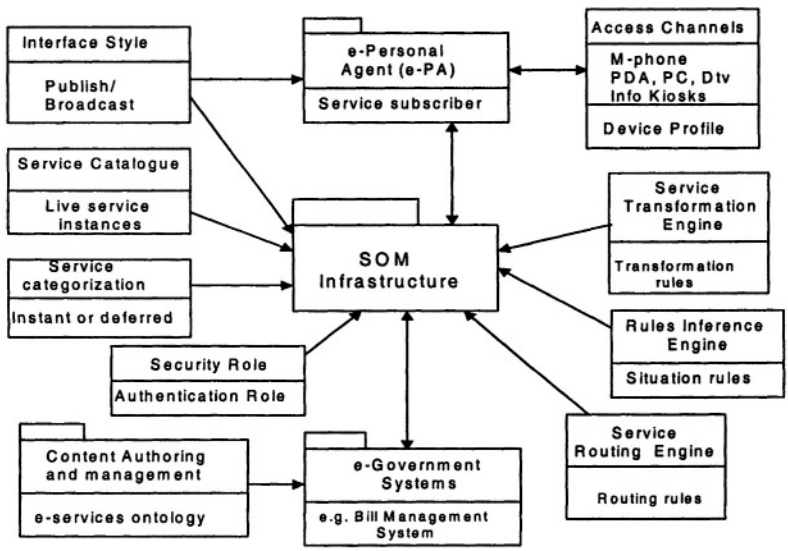

Figure 4: The Service Oriented Middleware (SOM) infrastructure

In developing adaptable EPSD systems, various concepts and technologies need to be considered. As mentioned above, this research envisions a concept whereby a single application is dynamically configured

from COTS components stored in repositories provides services that are adapted to an access device/channel depending on the user's context. To achieve this, the following process components are required to be developed:

a) a meta-language for COTS-component and access device profiling,
b) a Service Oriented Middleware infrastructure that is depicted in Figure 4 which utilizes various engines and uses the meta-language to match service instances to access devices, and
c) a process for creating and adapting service instances to access devices.

These new elements are described next and Figure 5 below depicts the overall architecture of the proposed framework.

5. PROFILING COTS SOFTWARE COMPONENTS AND ACCESS DEVICES

The concept of profiling helps us to understand the capabilities of COTS software components and access devices in specific operational environment (Voas 2000). In the context of the proposed COTS-Oriented adaptive e-services, profiling involves developing:

(a) a description of the known capabilities and characteristics of the COTS software components under consideration;

(b) a description of the known capabilities of currently available access devices;

(c) a description of the applications created using the COTS software components;

(d) a description of the service instances that are instantiations of the application developed using the COTS components.

For this, three main profiles – *the abstract, concrete* and *instance profiles* - which are described later in this section, need to be defined. However, to guide the definition of these profiles, the following questions need to be answered:

(a) what will be the formal semantics of both the abstract, concrete and instance profiles that can support effective service provision by integrating, configuring and adapting service instances?

(b) what characteristics of profiles can be determined during service instance creation?

(c) how can the proposed Service Oriented Middleware (SOM) best use the profiles to effectively create service instances, match, adapt and route them to the access device used based on the user context?

(d) how can profiles be integrated with the SOM so that it can use them to provide effective service provision?

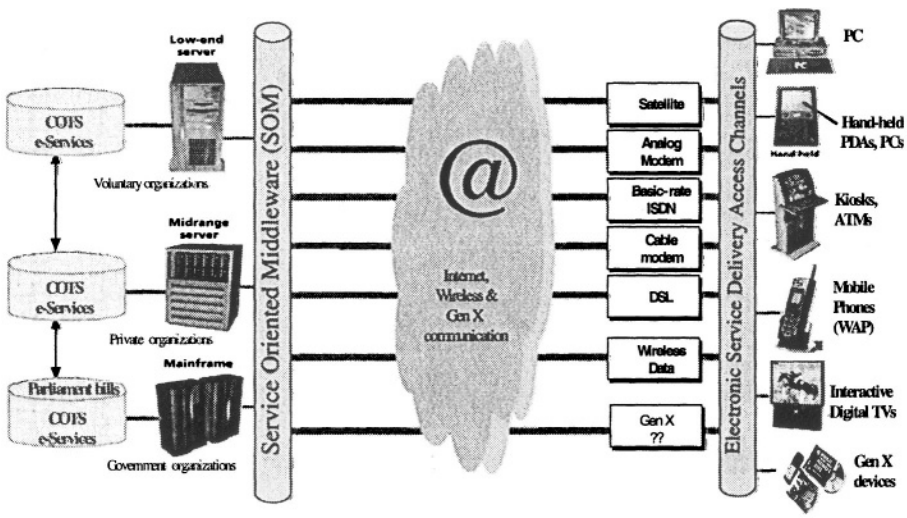

Figure 5: Architecture for the COTS-Oriented adaptive application infrastructure framework

To answer these questions, the proposed SOM needs to reason about the characteristics of the COTS-component and the characteristics of the access devices such as interoperability, assumptions, interface and interaction requirements, (Capra et. al 2000, Marvie et. al 1998). For the SOM to reason about these characteristics, a Profile Description Language (PDL) that adequately captures these characteristics is required. The PDL would be a meta-language that offers syntax and semantics for expressing the characteristics of both COTS software components and access devices. The SOM will speak the language of the PDL, reason about the COTS-components and select the ones that meet a consumer's service request. When the SOM receives a consumer request for a service, it uses its rules inference engine and situation rules to dynamically construct and configure an application from stored COTS software components, instantiate the constructed application to create service instances based on the user context knowledge, adapt and route the service instances to relevant access devices. This will be a matching process between the requested service and the characteristics of the COTS component on one hand and the characteristics of the access channel used on the other, performed by the SOM. The results will be matched, adapted and then routed to the appropriate device.

To cope with the evolution of both the COTS-components and access devices, the PDL will be independent of specific characteristics of COTS-components and access devices. It will be a meta-description language that defines the SOM's view of the COTS-component, service instance and

access device. XML-based formats such as Portable Application Description (PAD) or Open Software Description (OSD) can be used for developing the PDL meta-language. PAD is an XML-based format for describing downloadable applications and allows creating an application's description only once. OSD is also an XML-based format used by W3C to describe software components and their dependencies in a distributed environment.. This will be very useful as the proposed process constructs the EPSD systems by integrating multiple COTS software components that are stored in distributed repositories. In order for the SOM to be able to create and adapt service instances, the following 4 key profiles are required:

(a) **COTS-component Abstract Profile** that is an abstract description of the component's architecture and its functional and non-functional properties. It also describes the component's properties such as interconnection mechanisms, published interfaces, performance, reliability, security, i.e. the overall Quality of Service provided by the component (Wang & McClean 1999).

(b) **Application Concrete Profile** that is a concrete description of a set of interconnected COTS components that have been dynamically configured to create adaptive services. COTS component attributes such connector types, interface types, provided interfaces, required interface, etc. (Ning 1999) are used to create the concrete application profile.

(c) **Access Device Concrete Profile** that is a concrete description of the access device's characteristics and capability features. Typical device features that will be described are: mobility , i.e. smart mobile phone, PDA; fixed, i.e. inforkiosk, PC; display screen, i.e. interactive digital TV, desktop PC, mobile phone. The SOM will use device profile characteristics to match and adapt service instances.

(d) **Service Instance Profile** that is an instantiation or the execution of the application concrete profile to create service instances that are uniquely adapted and routed by the SOM to the access device used based on the user's context. The service instances are created based on the context knowledge which is defined as a set {*time, access device, user location}*. The SOM first uses the *rules inference engine* and *situation rules* to construct a service instance, then the *service transformation engine* to transform or format the service based on the access device and then the *service routing engine* to forward the required service to the access device. It is possible that many similar service instances can be created during service request. For this, the SOM will maintain a 'service catalogue' to keep information about 'live' instances and destroy those that their life has expired.

To create a service instance, the SOM performs three fundamental processes. First, it will check the service catalogue to determine that no "live" service instances match the requested service. If not, it finds the

relevant COTS components using component abstract profiles. Secondly, it dynamically constructs the required application based on the application concrete profile. Then finally, it executes the constructed application to create service instances that are delivered to the access device. Sometimes, existing instances can be reused or reconfigured and connected together with the newly created ones.

6. CONCLUSION

The proposed research aims to provide e-government systems developers with a smart systems engineering process. The systems development process envisioned in this research aims to provide a flexible, mixed system development environment with process instances that allow some unique parts of the EPSD system to be custom developed; some parts of the system to be configured and integrated from multiple COTS software components; some parts of the system to be rented; some parts of the system that rely on the state-of-the-art technology to be leased competitively from the market while some parts of the system or technologies to be tailored from systems or technologies that are developed for other business domains. The advantages of building systems by integrating COTS component have been extensively reported in Ncube (2000). This chapter therefore concludes by identifying some key future research initiatives that are necessary to realize the proposed process:

- **e-Personal Agent (e-Pa) :** this research envisions e-government services that are so inter-connected that everyone – private citizen, business and government people – would have computerized individual agents (e-Pa) updating them on almost anything or topic of their choice. This would allow private citizens and businesses the ability to have their entire government on-demand on their screens anywhere, anytime, whenever they want it. The e-Pa will enable users to subscribe to be updated about any service they require from the government.
- **A Service Oriented Middleware (SOM)**: this is needed to handle all the service requests by subscribers and for transforming, adapting and routing service instances to the access device used. When the SOM receives a service request, it uses the request to search for service instances that are still 'alive' which can provide the requested service. If there are no 'live' service instances it then searches the COTS component repositories for relevant candidate components using abstract profiles, reconfigure the components to create a concrete application that is then executed to create service instances that are then adapted and routed to the access devices based on the user context. To achieve this,

the SOM will need 'reasoning' capabilities, therefore a *rules inference engine* with its *situation rules,* a *service transformation engine* with its *transformation rules* and an *intelligent service routing engine* with its *routing rules* need to be developed.

- **Profile Description Language** – there is a need to develop or specify a complete Profile Description Language (PDL) in order to understand and describe the capabilities and characteristics of both the COTS-components and access devices. The PDL will provide formal semantics for modeling abstract, concrete and instance profiles for COTS-software components, access devices and services that will be used by the SOM to match and adapt service instances to the right context and the right access device. XML-based formats can be used for the development of the PDL meta-language.
- **e-Authentication Management Framework**: the e-AMF is needed to build and enable mutual trust that is required to support wide spread use of electronic interactions between the public and the government. The e-AMF will be an integral part of the proposed COTS-Oriented Process and will be tightly integrated with the SOM. The e-AMF will be responsible for establishing a method for satisfactorily establishing' unique user identities. It will provide a secure consistent method for proving identity whenever a user requests or accesses government service. Latest COTS technologies such as electronic signatures, e-IDs or universal identification can be used.

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