A Proposed Architecture For Mobile Government Transactions

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Abstract: *As testified by the established penetration of mobile devices world-wide, as well as the emergent enrichment of both informational and transactional mobile service content via protocols such as i-mode, mobile services may constitute the next technological leap in the advancement of electronic service delivery. The integration of mobile technology with electronic government services, in particular, presents substantial promise to bring the "anywhere-anytime-anybody" e-government service vision one step closer. This paper presents an architecture that integrates workflow-based one-stop government service delivery with secure mobile transactions, offering support not only to "passive" informational services, but also to transactional services realized through mobile triggering of e-government service workflows. Such an integration further enhances the established benefits of electronic government service delivery whereas it additionally creates a co-operative "win-win" situation for service end-users, administrative employees, e-government service providers and mobile operators alike.*

Keywords: Mobile government, system architecture, G2C, G2E, G2G.

1. Introduction

E-government could be described as the continuous optimization of service delivery, constituency participation, and governance by transforming internal and external relationships through technology, the Internet, and new media (Gartner Group, 2000; Roy, 2005). In this line of thought, there are more than one billion mobile devices (ITU Internet Reports, 2004) in use around the world today that could act as virtual kiosks and as gateways to governmental information. "Always-on" individuals, mobile employees, and transient communities will be the constituents of the future (Di Maio, 2002). The emergence of mobile technology creates an unprecedented opportunity for governments to bridge the digital divide and provide service to both citizens and employees anytime, anyplace, through portable devices (Townsend, 2002; Foley, 2003).

The most prevailing motives for conducting m-government transactions are the maturity of the mobile market, reaching a 83% penetration rate surpassing fixed telephony subscriptions in Europe (Netsize, 2004), and the high level of mobile phone *uniqueness* (Watson *et al.*, 2002). *Uniqueness* corresponds to the personal nature of the mobile phone (mobile phones are used by only one person anytime and anywhere) and to Location Based Services (LBS) enabling citizens to receive information that is dependent based on time, location, role and learned preferences. The combination of these two motives provides a platform for strong authentication and personalized transactions to a mass market including minority segments such as the elderly and the low-income groups (Becker, 2005; Woolfson, 2004). Innovative and radical services applied through mobile technology may significantly improve the operations and communication efficiency of governments (Chaba & Kumar, 2002). Such an innovative service is to extend public administrative transactions in ways that actively involve citizens and government employees, allowing them to communicate and collaborate with public administration systems through their mobile devices in a transparent and trusted environment. In this way, citizens are not only provided with up-to-date information through mobile notifications; but are also enabled to

interact with and as allowed trigger administrative workflows in order to obtain documents or structured information, request the progress status of applications already filed, ask for delivery of issued documents back to themselves or for direct forwarding to third parties such as banks, private organisations, other public authorities. Moreover, government employees will be able to retrieve case-specific information, in the context of transactions with individual citizens.

According to the aforementioned, the so-called M-GOV architecture is described in this paper as an approach towards mobile delivery of seamless government services. Typical M-GOV application scenarios include cases where citizens retrieve static or dynamic administrative information (e.g. directory info about public agencies, how-to-apply instructions or current tax filing dates, and open job postings, respectively), personalized information (e.g. taxation or social security profile), file applications for administrative documents (e.g. a birth certificate), request transaction status for applications already filed, ask for delivery of issued documents back to themselves or for direct forwarding to third parties; and mobile government employees retrieve case-specific information in the context of on-the-spot transactions with individual citizens (e.g. a traffic police agent checks for a driving license or plate number, an ambulance doctor checks for a health profile).

In the next section, current applications are discussed followed by M-GOV objectives and architecture. Section 4 provides the benefits of such an architecture before concluding by illustrating a summary of the propositions put forward in this paper.

2. Current Practice

Mobile government functions complementary to e-government and aims to extending the number of citizens that become recipients of electronic governing services and bridging the digital gap, allowing citizens and employees the freedom to access essential information anywhere, anytime. This objective follows the arguments of improved quality of government-to-citizen (G2C) service, provision of innovative services, operational efficiency, increased citizen participation and transparency (Seifert & Bonham, 2003).

Government organizations, already, have stood to reap the benefits of a wireless world. Several sectors have been located that already offer G2C or government-to-employee (G2E) services. Following the general taxonomy of e-government sectors by Seifert and Bonham (2003), regarding G2C services the more common m-sectors are: health, transport, tourism, commerce, e-learning, electronic payments, emergency services, electronic voting and local wireless networks for public use (hot-spots). Certain examples of services are: real time alerts to citizens for upcoming emergencies, SMS weather forecast, use of wireless devices by students in order to register for exams, get results and search libraries' archives. Mobile and wireless services currently offered to employees (G2E) are: fleet management, e-policing, conducting the necessary audits and fast issue of licences, tracking down the exact location (in 3D) of an employee in a building, direct printing and receiving e-mail on mobile devices. According to application domain in Table 1 we depict indicative initiatives and applications throughout the world that could be integrated in the mobile government sector.

Service	Description	Source
M-transportation	SMS notifications: The driver receives an estimation for the total time duration of his transport. The notification could be time or event based	NTUA (2005)
M-payment	Drivers in London can pay tolls with SMS text messages	Bradford (2003)
M-learning	Pupils are taught the history of hip-hop and must also analyse and relate to hip-hop lyrics and their meaning. They must also compose their own lyrics and make their own rap on the PDA	Crossroads Copenhagen (2005)
M-voting	Norwich City Council and Ipswich Borough Council are providing new means for voting through the use of text messaging using mobile phones	BBC (2003)
M-tourism	Using a handheld device with the CRUMPET system integrated, tourists can check out an array of information such as the nearest Italian restaurant in their locality or the times of public transport in another city using a digital map of that city	CRUMPET (2003)
M-health	Use of mobile applications in emergency management so as to improve the safety and security of both the public and the emergency workers themselves	XMOTION (2003)
M-weather	On demand localised forecast for the next six hours for any UK postcode, town or city	MetOffice (2005)
M-policing	The Philippines National Police – the country's unified police force – introduced a text messaging system in 2002 enabling the public to report wrongdoings by police officers as well as by criminals	Alampay (2003)
M-welfare	The Hong Kong government sent a blanket text message to 6m mobile phones in a bid to scotch a spoof internet story spreading fears about Asia's mystery bug	Guardian Unlimited (2003)
M-emergency	The Italian Ministry of Foreign Affairs, during the aftermath of the Asian Quake, sent an SMS to Italians located in the struck area. The message was: "Answer indicating your identity, health status, and place where you are". The Italian Government obtained the list of people located in struck area from phone companies, that provided the information based on the international roaming services	mGovLab.org (2005)

Table 1: Indicative M-government services

Glancing through the m-government services employed today, it could be stated that those applications are still in an embryonic stage and mainly focus on SMS notifications and e-mail. To benefit from the dynamics of m-government, citizens, civil servants and businesses should be able to retrieve, update and send information through a virtual mobile desktop. Although, electronic government-to-citizen refers to the use of information technologies by government agencies to provide citizens with more convenient access to government information and services, to improve the quality of the services (World Bank's e-government website, 2001), integrating all these services to one access point may prove a complex issue. Conventional implementations present several problems, such as repetition of development, highly complex solutions and difficult integration due to diverse technologies. Thus, a single platform of management and delivery of governmental transactions should be developed to minimize the aforementioned drawbacks. To this direction, the proposed M-GOV architecture is recorded.

3. The M-GOV Architecture

3.1. Objectives of the M-GOV architecture

The top-level objectives of the M-GOV architecture are threefold: (a) at the level of *accessibility*, enhance public administration processes by exploiting the capabilities of current mobile technology in order to render public administration transactions accessible, by both citizens and government employees, in a truly anytime/anyplace/by anybody fashion; (b) at the level of *integration,* provide a single location- and time-independent gateway to public administrations' certificates and data that allows m-citizens and m-workers to seamlessly access case specific government resources across different government networks; and (c) at the level of *transparency*, make the provision processes of public administration services more transparent to the citizens through a trusted and secure workflow management approach.

To this end, the M-GOV architecture extends administrative transactions in ways that actively involve citizens and government employees, allowing them to communicate and collaborate with government systems through their mobile devices in a trusted environment. The main idea of the M-GOV architecture is not only to provide citizens with up-to-date information through mobile notifications, but also to enable citizens to interact with the administrative transactions and allow triggering of such transactions for delivering public certificates to authenticated third parties (banks, private organizations, public authorities) and individuals. Application scenarios that can benefit from a mobile service architecture, like the M-GOV, include the following:

- citizens retrieve information such as dynamic administrative notifications (e.g. current tax filing dates, open job postings), static administrative information (e.g. directory info about public agencies, how-to instructions for requesting administrative services), personalized information (e.g. taxation or social security profile);
- citizens file applications for administrative documents (e.g. a birth certificate), request transaction status for applications already filed, ask for delivery of issued documents back to themselves or for direct forwarding to third parties;
- government employees retrieve case-specific information, in the context of transactions with individual citizens (e.g. a traffic police agent checks for a driving license or plate number, an ambulance doctor checks for a health profile).

3.2. The M-GOV Operational Approach: An Example

The M-GOV operational approach that considers active participation of citizens to inter-organizational transactions for public services can be best presented by means of an example; to this end, an M-GOV based implementation of a public transaction for issuing passports is presented below. Provision of this transaction entails enactment of a number of workflows in different public authorities, which can proceed as follows:

Process initiation: The interested citizen initiates a "passport issue" request to an M-GOV transaction provider (ideally the responsible public authority), either from a fixed location (e.g. home or office) using an internet-enabled PC, or while on the move using a mobile device. The requesting citizen may also choose an interaction channel interact (PC- or mobile-based interaction interface) for the rest of the process, as well as set options for retrieving status information (see below) as well as handling of the transaction outcome (the issued passport).

Transparent collaboration between public agencies: The public agencies involved in the process are automatically triggered by the M-GOV architecture to check the information provided by the citizen and verify the data with their internal systems, following their current internal workflows. The different public agencies continue to work with their current methods and their existing applications, but each public agency participates in the integrated process in a manner transparent to the other participants as

well as to the requesting citizen. Upon verification of request data the necessary documents are issued and automatically forwarded to the public agencies next in the workflow chain in order to further proceed with the process.

Citizen interactivity: During the back-office processing of a citizen's request, the latter has access to status information. A number of options exist for this access, including fixed vs. mobile channels, push vs. pull mode of information retrieval, detail and periodicity of updates etc, that can all be set by the requesting citizen while profiling the initial request. Even if the requesting citizen seeks no status information, the latter is always informed upon transaction completion. What is more, the requesting citizen has a number of delivery options for the passport eventually issued, possibly associated with applicable charges.

Document exchange: A number of options exist for submission of input data and documents. Simple information can by entered by the end user; official administrative documents may be posted or faxed by the end user, requested from the issuing agencies on the end users' behalf, or directly retrieved from a trusted third notary. Similarly, a number of options exist for delivery of output. Simple information may be delivered on the mobile device, official documents may be returned to the end user by post or fax, directly forwarded to other agencies or simply deposited at a trusted notary. All these options can be further evaluated, with focus on the concept of a trusted third notary service able to store and forward official documents on the users' behalf. Security policies, billing issues as well as detailed business models are an additional issue that calls for further investigation.

Trust and confidence: Successful implementation of the M-GOV operational approach requires several levels of confidence to be employed: initiation of citizen request must be coupled with authentication procedures; status notifications provided to mobile requesting users may include sensitive personal data, which means that integrity and confidentiality must be addressed. Furthermore, no communicating entities (citizens, public agencies and any third parties) should be able to repudiate committed transactions. To provide these basic elements of trust, digital signatures and certificates for both requesting citizens and public employees need to form an integral part of the M-GOV architecture.

3.3. The M-GOV Approach to Mobile Workflows

In a cross-organisational multi-step workflow, typical of current public administration processes for public service provision, several workflow management "domains" (i.e. WfM engines or manual WfM schemes) need to co-operate for each workflow instance, whereas associated control data need to be commonly accessible to the WfM domains involved. These workflow control data may be distributed across organisational locations. Similarly, the process definition data (in the case of WfM engines) and/or the process procedural knowledge (in the case of manual WfM) may be distributed across domains, and parts of these may be transferred to individual domains from some master source during process execution. Interfaces to handle supervisory operations or application invocation may be supported as distributed features or localized to particular domains. The implementations required to manage the distribution of workflow across multiple domains are thus complex and numerous.

Workflow process deployment is an important part of process enactment in e-government applications. The process below consists of activities A, B, C and D. Activity A is executed first, followed by B and C which are executed in parallel, and lastly D is executed, but only when both B and C have finished. This may be modelled in the following directed graph:
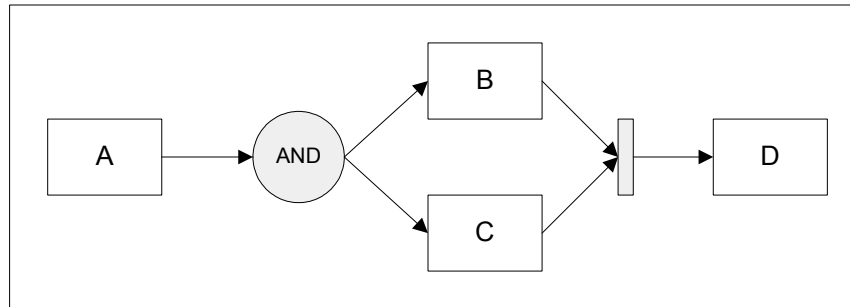
**Fig. 1.** An example of a very simple workflow process definition.

In order to successfully transfer traditional transactional properties to the mobile environment, the M-GOV architecture proposes the concept of a Mobile Activity Agent (MAA), as an active entity that allows triggering of workflow tasks from mobile users in an anytime/anyplace fashion, as long as the task preconditions are met. By applying this concept, workflow patterns such as the previous ones reflect the synchronization needs for process control and can identify parent-child relationships that will eventually exist between MAAs. The example of Fig. 1 contains a simple sequence pattern consisting of A followed by B and C; an "AND" fork pattern that requires the parallel execution and synchronization of activities B and C; and one more simple sequence pattern consisting of B and C followed by D. In this example a single synchronization point is required, the one that marks the end of activities B and C; therefore, at least one MAA will be required to perform this task.

To facilitate identification of process synchronization points and allocation to MAAs, a set of pre-defined agents is envisaged. Simple examples include an End-type Activity Agent (for simple activity with no next tasks), a Sequence-type Activity Agent, AND-, OR-type agents. Each of these agents will be endowed with the logic required (a) to participate in protocols for synchronization with a parent agent and any spawned child agents, and (b) to actually spawn child agents, keeping track of their definitions and establishing communication channels with them. Such a mobile distributed workflow management approach provides a number of advantages, including

- improved control of the process when data is distributed, with less management intervention, and less chance for delays or misplaced work;
- improved quality of service, by responding more quickly, since the person that has to accomplish the step is (practically) always available;
- improved user satisfaction, by giving the user confidence that everything is under control, as well as the satisfaction of completing assigned work with fewer delays.

3.4. The M-GOV Technical Architecture

This subsection presents a conceptual view of the M-GOV architecture (Fig. 2) and summarizes a description of the M-GOV architectural components that altogether provide mobile administrative workflow transactions accessible to citizens and public employees through a single site of reference, the M-GOV portal.
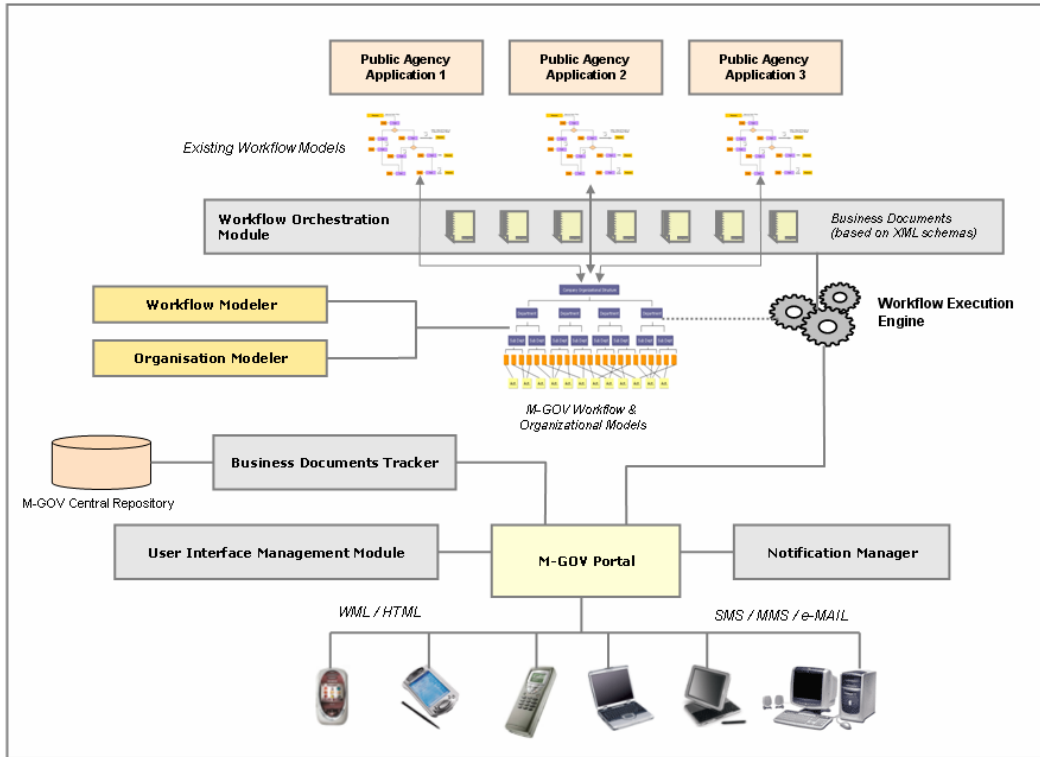
Fig. 2. A conceptual view of the M-GOV architecture.

Workflow Modeler: This module enables an M-GOV administrator to define the administrative workflows that will be available to the end-users (citizens or government employees). This task includes the definition of public agencies and roles of government employees for each public agency that participate in the workflow, the visual design of the workflow (including activities, tasks, flows and conditions) and the assignment of activities to roles. The elicitation of activities, roles and their associations is guided by the thorough examination of current information systems and internal workflows already in place within the public agencies. It should be mentioned that in the context of the m-GOV architecture the Workflow Modeler must be utilized in order to visualize the boundary activities of the public agencies (activities that trigger inter-organizational communication) as these activities are required for workflow integration. Optionally, this tool could also be used for modeling internal workflows of the public agencies according to WfMC process definition guidelines.

Workflow Orchestration Module: This module enables integration of workflows practiced by different public agencies. Business documents (mentioned in Fig. 2 as business objects, e.g. a passport) will be utilized as a communication bridge between different workflow domains. The module will support the definition of these documents as business objects (including attributes, operations and associations) or XML schemas. In case the inbound document of an activity differs from the outbound, the module supports the linking of these disparate documents through the specification of a mapping. Information exchange can be supported through web services. In case that the activities performed are not supported by information systems, the module will generate end-user interfaces enabling a workflow participant to inform the workflow engine about execution of an activity and pass control on to the next activity of the process.

Workflow Execution Engine: This module runs the workflow models defined by the Workflow Modeler. The engine is used to control the execution of activities of public service processes and activate (through web service invocations) the applications already operating within the public agencies involved. This module is used to monitor the status of running process instances.

Business Documents Tracker: This module enables users to track documents as they move through various stages of the workflow process. It also supports the creation of advanced queries to extract essential information from the tracking database (e.g. captured information about the document source and destination, document name and type, datestamps/timestamps and the like).

Organization Modeler: This module enables an organization to register in the workflows supported by the m-GOV architecture under specific roles and also to establish partnerships with other public agencies. It is also used to model organisational structures (affiliated companies, branches, departments), register personnel of the organization and establish relationships between roles and employees. Note that the concept of a "blank organization" may be used that will include all citizens. Individual end-users (citizen or government employees) can define their profiles and register their communication means (characteristics of their mobile devices and other parameters that may affect user interface and access modes).

User Interface Management Module: This module provides a friendly editor for the construction of XML and XSLT schemas that allow the representation of data to alternative devices. When a page is requested the module is responsible for synthesizing and deploying the user's interface on the user's device, relying on the user's profile and a description of available devices to invoke the most appropriate method of presentation and interaction. The purpose of this module is to alleviate the problem of having to design and develop a separate user interface for each device that a mobile user might be using; this also helps delivering a more consistent interface across devices and applications.

Notifications Manager: This module generates and sends alerts to the workflow participants (citizens and governmental employees). Alerting functionality can be mainly used in two cases: (a) for informing a citizen about dynamic administrative information (e.g. current tax filling dates) or updates to monitored static information (e.g. updates to directory info about public agencies, changed how-to instructions for requesting administrative services); and (b) for informing a citizen or field employee about status of a workflow process instance that the former participates in (in these cases the alert should include a link to the M-GOV portal page for the specific process instance). Indicative notifications mechanisms include SMS/MMS and email.

Public Agency Applications: These are the information systems and applications currently deployed within public agencies. These internal systems may be implemented on heterogeneous technological platforms and also lack interoperability. However, high-level, workflow-based, invocation of functionality from the existing application portfolio can help establish a consistent and interoperable layer of functional capabilities across different public agencies.

3.5. The M-GOV Trust Infrastructure

The M-GOV architecture needs to be coupled with a trust infrastructure offering basic features of trust and confidence, namely authentication, integrity, confidentiality and non-repudiation. Value added trust services may also be designed and deployed, enabling mobile end-users to ask for delivery of official documents to third parties, or storage to e-notarization operators for future reference. Fig. 3 illustrates the M-GOV conceptual trust infrastructure, whose components are described in short in the following.
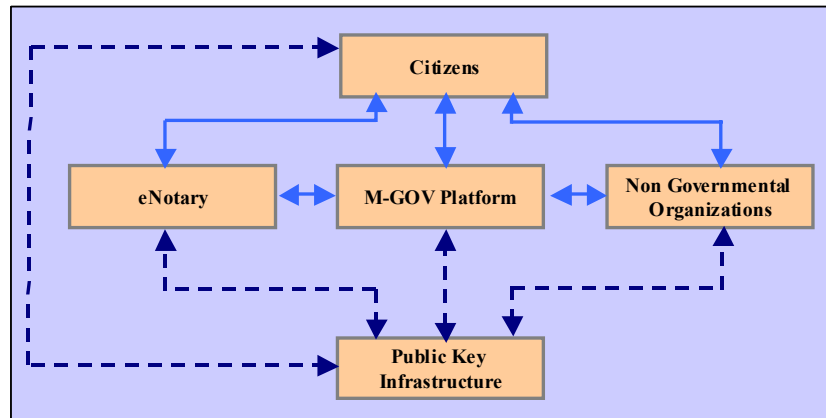
Fig. 3. The M-GOV conceptual trust infrastructure.

Public Key Infrastructure. The main entities of the M-GOV architecture (public authorities, third party institutions, eNotary entities) need to be mutually authenticated and communicate in a secure fashion using digital signatures and certificates. Citizens may also be authenticated with the M-GOV architecture by providing appropriate credentials. The M-GOV certificates management can be implemented through a Public Key Infrastructure (PKI) hierarchy, whilst Certificate Policies (CPs) can be designed and established per case-use scenario to ensure proper usage. Certification Service Providers (CSP), including CAs (Certification Authorities), RAs (Registration Authorities) and Directory Providers (offering certificate's status services) can all be incorporated within the M-GOV architecture, defined as actors of M-GOV process workflows.

eNotary Services. An eNotary entity provides notarization services for electronic documents, i.e. unambiguous proof of the existence of specific data at a specific time. An eNotary service needs enhanced e-archiving capabilities for secure storage and distribution of administrative documents. Exploiting the services of an eNotary as a trust and storage facility, mobile users can request the delivery of administrative documents from the M-GOV platform to an eNotary entity; the latter performs time stamping, digital signing and archiving of these documents for any future reference. Once a document is delivered to the eNotary, the owner is capable to send a certified copy to third parties, such as banks or private sector companies.

4. Discussion, Expected Benefits

The M-GOV platform enriches the advantages offered to various actors of the mobile government service chain. Administrative service users (e.g., citizens, professionals, etc.), administrative service field employees (from public sector, local and regional authorities), service providers and mobile operators could benefit from the anytime and anyplace transactions offered by the M-GOV platform in a variety of qualitative and quantitative indicators.

4.1 Administrative Service Users

The M-GOV platform identifies to administrative service users tangible advantages, not only with respect to the corresponding non-ICT model (paper-based access to administrative workflows), but also compared to Internet-based access. Individuals do not have to be physically present to the service delivery point (e.g., front-end office, kiosk, one-stop service counter, etc.), and, thus, they save time, due to the avoidance of transport, waiting, transaction and result delivery queues. Additionally, they don't have to physically remain on a fixed location where Internet access is provided, and, thus, are not isolated form the community or excluded from routine tasks while being served. The service can be provided to users through a mobile device, without the need of any extra infrastructure, costs, or knowledge skills. The benefits of the M-GOV platform exploitation for the user community can be summarized in the following:

- Facilitate access to administrative transactions, in terms of speed, as well as skills and costs
- Ensure mobility, without compromising the capability to request administrative services while away from a counter or a computer
- Assist seamlessness of everyday leaving, since accessing an administrative service through the M-GOV platform requires no time loss, or moving to an Internet access point
- Support e-inclusion, since a simple mobile phone can now serve, through the M-GOV platform, as a gateway to local, regional or national public administration
- Take advantage of the high penetration of mobile devices to provide personalised administrative transactions, and to efficiently support e-participation initiatives

4.2 Administrative Service Field Employees
Recent analysis (Lee, 2003) reports that the 80% of UK organizations that have implemented mobile data applications noted productivity gains and workflow improvements. The M-GOV platform enables the anytime and anywhere access to back-office processes and information databases, providing a substantial improvement. It enhances the efficiency of the public sector and upgrades the levels of services provided to citizens. Field employees gaining access to administrative workflows and back-office information systems through the M-GOV mobile services are presented with a unique opportunity to alleviate from their field work inefficiencies due to lack of collaboration with their back-office. The benefits of the M-GOV mobile services to field employees for accessing back-office administrative resources can be summarized in the following:
- Facilitate access to back-office resources, in terms of simplicity, capabilities and speed enabling the mobile office paradigm
- Support mobility and seamless field work, since the work status is permanently visible (Domingos et al., 1999), ensuring minimal productive time loss and improving mobile worker productivity
- Take advantage of the advanced secure modules of mobile devices to provide reliable, authenticated and secure administrative services

4.3 Administrative Service Providers
The M-GOV platform presents a number of concrete benefits to third party administrative service providers, which are summarized as follows:
- Facilitate simplicity, timeliness and transparency to the administrative service delivery
- Save operational cost and improve resource management, in terms of reduction of front-office personnel, already been initiated with Internet-based service delivery, and re-allocating resources to mission-critical processes
- Improve field work, in terms of cost-effectiveness of field employees as well as exploiting new capabilities for field-based processes

4.4 Mobile Operators
Administrative service transactions through the M-GOV platform provide a source of solid benefits, or even potential revenue, for mobile operators, which are summarized as follows:
- Enrich the mobile services palette offered to subscribers
- Accelerate the penetration on the mobile data market offering M-GOV platform services to citizens, service field employees and administrative service providers
- Profit from complementary value-added services that will be juxtaposed with the M-GOV platform, such as Virtual Dial-in Private Networks (VPDN), directory services and content delivery
- Capitalize the considerable data volume, achieved through the transactions through the M-GOV platform, that they convey

5. Conclusions

In this paper we introduced an integrated architecture that takes advance of the mobile services penetration to offer workflow-based, one-stop, secure, government service delivery to mobile and nomadic users. The introduced architecture enhances the traditional workflow management paradigm, and proposes a platform which offers a set of tools that enable various actors of the m-government transactions provision chain to orchestrate, integrate, provide and manage workflows of discrete administrative procedures. The platform enables the dynamic definition and provision of administrative workflows to administrative service users (e.g., citizens, professionals) and administrative service field employees, supporting both the pull and the push information models. Advanced modules that are proposed in this paper establish trust and confidence during the provision of the M-GOV platform's transactions. The M-GOV platform enriches the benefits offered by the traditional Citizens Relationship Management (CRM) architectures to administrative service users and field employees offering anytime and anyplace e-government transactions. For those individuals, through the usage of the M-GOV platform, tangible benefits emerged in terms of speed, productivity gains, costs, and efficiency. Additionally, the M-GOV platform presents a number of concrete advantages to third party administrative service providers and mobile operators, enabling the enrichment of the services palette that they are offering to end-users and the public sector.

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