Towards Requirements for a Reference Model for Process Orchestration in e-Government

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Abstract. A big challenge for governments all over the world is to improve the service provisioning to their clients, citizens and businesses. One way of improving service-provisioning is by means of a a one-stop-shop that integrates services that are performed by different semi autonomous agencies. This requires the coordination of service-delivery processes that run across different agencies. This is also called process orchestration. As little is known about process orchestrators, governmental decision-makers need support in designing them. This paper investigates the applicability of existing reference models from domains that are closely related to process orchestration, the Workflow Reference Model and the extended SOA reference model, to governmental decision-makers for implementing process orchestration in e-government, and identifies several main requirements for a reference mode for process orchestration, based on a case study performed at a business counter.

1 Introduction

A big challenge for governments all over the world is to improve the service provisioning to their clients, citizens and businesses. This is partly motivated by the aim to reduce the administrative burdens for citizens and businesses [1, 2], but is also demanded by its clients, whose expectations regarding service delivery will continue to rise as they get more and more accustomed to on-line trading and communicating at any time of the day [3].

A first step to satisfy this demand is offering access to governmental information and services on-line via the Internet. A next step is the provisioning of 'one-stop-shop'-services [4], where services of different governmental agencies are combined or integrated. An example is a business counter that functions as a single point of contact for interaction with different kinds of governmental agencies.

Both steps in improving the governmental service-delivery process have to deal with the problem of fragmentation of governments [4], as these service-delivery processes often include activities or sub-processes that are performed by various public agencies [5, 6, 7]. This requires the coordination of service-delivery processes that run across different agencies. This is also called process orchestration.

This problem of coordinating cross-agency service-delivery processes is not specific to the public sector; also in the private sector, businesses are looking for ways on how to coordinate their inter-organizational processes. Specific for the public-sector is, however, the strong emphasis on transparency, consistency, and non-discrimination of the service-delivery processes. Maintaining transparent processes is particularly important when service-delivery processes run across multiple, semi-autonomous agencies. This large number of more or less autonomous agencies involved in a particular service-delivery process is also a particular characteristic of the public sector.

A potential technological solution to the problem of coordinating sub-processes that run across different agencies is web service orchestration. Web-Service technology is based upon the notion of a Service-Oriented Architecture (SOA), an architectural paradigm according to which application functionality is not provided by large monolithic information systems, but by means of web-services.

Coordinating these different web services by means of a process flow in which the web services are invoked according to a predefined sequence is called web service orchestration, and the standard language for web service orchestration is Business Process Execution Language for Web Services (BPEL4WS, or BPEL for short).

If all governmental agencies that are involved in the service-delivery process provide access to their sub-processes and information systems by means of a web-service-interface, BPEL-based orchestration is a promising technological solution to the problem of coordinating processes that run across different agencies.

Within governments, little is known about how to coordinate cross-agency service-delivery processes, the advantages of web service orchestration-technology [8], and how web service orchestration-technology can be applied to support in coordinating cross-agency service-delivery processes. This indicates that there is a need for a reference model that can support governmental decision-makers in implementing process orchestration in e-government.

The *goal* of this paper is to investigate the applicability of existing reference models from domains that are closely related to process orchestration, the Workflow Reference Model [9], and the extended SOA reference model [10] to governmental decision-makers for implementing process orchestration in e-government, based on requirements for a reference model identified at a case study.

2 Existing Reference Models

A Reference Model can be defined as "(a) generally accepted abstract representation that allows users to focus on establishing definitions, building common understandings and identifying issues for resolution. (..)" [11]. A reference model for process orchestration in e-government would contribute to gaining insight in how to implement process orchestration, guide the design process, and recommend addressing certain issues.

As workflow technology also concerns the automation of processes, its resemblance with web service orchestration is clear. Also, some researchers claim

that web service orchestration should take more notice of the lessons coming from workflow-research [12, 13]. For this reason, the existing workflow reference model may be relevant to decision makers facing the problem of implementing process orchestration in e-government.

As web services and web service orchestration are the main technologies for realizing a SOA, the extended-SOA reference model may also be relevant to governmental decision makers looking for guidance in implementing process orchestration.

2.1 Workflow Reference Model

The Workflow Management Coalition (WFMC) developed a reference model for Workflow Management Systems (WFMS) in order to promote standardization of, and interoperability and connectivity between the WFMS that have arisen over the years [14].

Figure 1 shows the Workflow Reference Model that defines the generic components and interfaces that make up a WFMS. This model aims at promoting the interoperability between different WFMS. We will discuss the components of a WFMS based on this Reference Model.

Central in the reference model is the workflow "enactment service" that consists of one or more workflow-engines. These engines execute the workflows, start new processes, select the people or applications that have to perform a task, send the necessary documents to the right people or applications, etc.

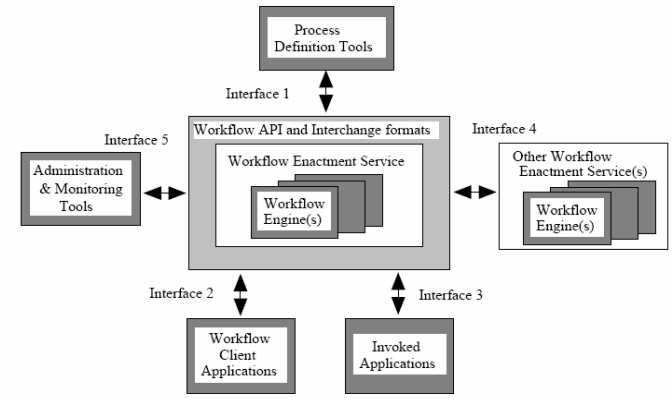

Fig. 1. Workflow Reference Model

The first interface concerns the process definition tools. The processes that are executed by the WFMS can be defined 'at design time' by means of a graphical process-editor for the process-flow, and with program-code or scripting for invoking external applications. This interface is implemented by means of XPDL,

the XML Process Definition Language [15]. This is a standard language for defining and interchanging processes designed by the WFMS. By means of XPDL, WFMS can implement process-definitions that are designed by third party process definition tools.

The second interface is with the workflow client applications. A client application is usually implemented by a graphical interface that consists of a 'worklist' with the work items that have to be performed by the employee. The workflow engine does the assignment of tasks to the employees.

The third interface allows the WFMS to start external applications, either to perform automated tasks, or to support employees in executing their own tasks. A standard template with the address of a customer filled in can be started to support the employee task of sending a letter.

The fourth interface allows different WFMS to communicate with each other, i.e. that at a certain point in the process, the WFMS can start a (sub-) process on another WFMS. Although it is possible to consider the development of very complex interoperability scenarios in which a number of different WFMS, possibly of different vendors, cooperate to deliver a single enactment service, this scenario is difficult to realize, as it requires that all engines can interpret common process definitions and maintain a shared view of process states across the different WFMS [9]. More realistic is a form of cooperation where parts of the process are transferred to another WFMS. The interfaces 1, 2, and 4 can be implemented by means of Wf-XML, a standard by the WFMC [16].

A last interface with the workflow engine is used by different administrative and monitoring tools. These tools can be used to control issues like status, progress, and workload, and to add new users and roles.

2.2 Extended SOA Reference Model

The extended-SOA reference model was developed by [10] to provide support for service composition and management to the basic SOA operations of publishing, discovering, selecting, and invoking a service.

Figure 2 gives an overview of the extended-SOA pyramid, with the basic SOA-functionality at the bottom, and the higher-level functionality on top. Whereas in the basic notion of a SOA only the roles of service-provider, service-requester, and service-directory were involved, the extended SOA adds the more advanced roles of service aggregator and operator, and replaces the service-directory with the more advanced role of a market-maker.

Composite services are services that are composed out of other services, which on their turn also can be provided as services themselves. Web service orchestration is one way of service composition, and realizes a composite service by invoking the different subservices in a sequence according to a predefined process-flow. An overview of other ways of WS-aggregation is given by [17].

Service aggregators bundle services and by doing this become service providers themselves. Typical tasks performed by a service aggregator are controlling the execution of the component services and managing the dataflow (coordination), subscribing to events or information produced by the component services, and

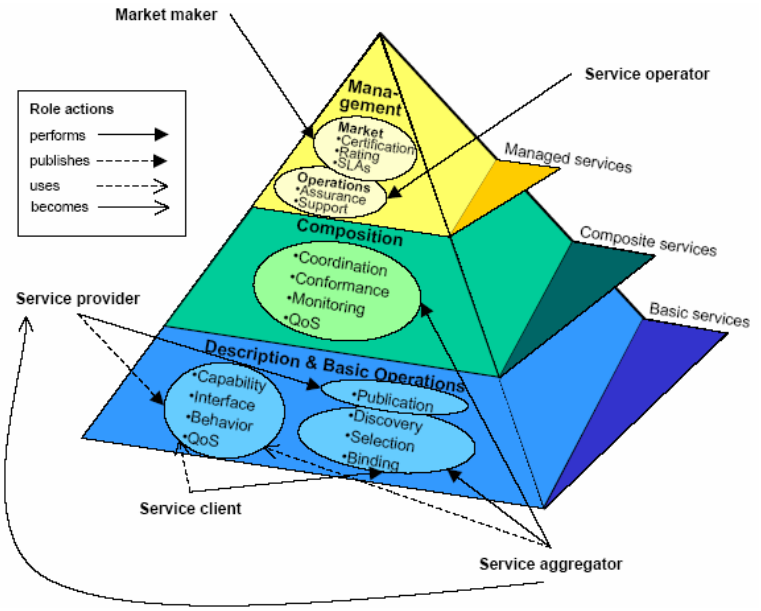

Fig. 2. Extended SOA Reference Model

publishing higher level composite events (monitoring), ensuring the integrity of the composite service (conformance) and leveraging, aggregating, and bundling the component's Quality of Service (QoS) to derive the composite QoS (Qos).

On top of these aggregated services, the extended-SOA reference model identifies so-called managed services in the service management layer depicted at the top of the SOA pyramid of figure 2. In this level, the higher-level functionality concerning the management of all the different (aggregated) services is situated.

The functionality in the managed-service-layer can be divided into two categories: market and operation. Certification of services, rating services, and guarding and monitoring service-SLA's are typical management activities performed by a market-maker, supporting the buying and selling of services on a market. Another kind of managed services concerns operation management activities such as providing assurance and support are performed by the service operator.

2.3 Comparison of the Reference Models

Both reference models can hardly be compared to each other, as they are completely different. This huge difference can however be explained by looking at important factors underlying both reference models.

The first important factor is the *initial goal of both reference models*. The goal of the workflow reference model was "to promote standardization of and interoperability and connectivity between the WFMS that have arisen over the

years" [14]. The goal of the extended-SOA reference model is more to de-mystify the concept of Service-oriented Computing (SOC) and to list and categorize all the needed functionality that is needed in successfully building systems using the SOC-paradigm. This explains why the Workflow Reference Model consists of parts of a WFMS, and the extended-SOA reference model consists of layers, roles, and functionality.

A second important factor is the *subject of the reference model*. The subject of the workflow reference model is the WFMS. The reference model prescribes the components it should be made of, and the interfaces between the components and the central workflow engine. The subject of the e-SOA reference model is the whole constellation of services, service-users, service-suppliers, and different kinds of third parties. This is a huge difference, but not so surprising when we consider that according to a SOA, systems are built out of many small functional services.

A third factor on which both models differ is the *level of aggregation* on which the models are situated. Where the Workflow Reference Model has components and interfaces as its objects, the e-SOA reference model has roles and functionality as its objects. Functionality and roles are situated on a business-level, whereas components and interfaces are situated on the implementation-level.

Although both reference models differ tremendously, both may contain important elements for a reference model that supports decision makers in implementing process orchestration in e-government. The following section will present a case study at a business counter, where a prototype of process orchestration using web-service orchestration was built.

3 Case Study at the Business Counter

The business counter is located in a medium-sized municipality, and offers a one-stop-shop to its entrepreneurs, integrating sub-services performed by different other agencies and organizations. For several services that are provided by different agencies, it acts as an account-manager that integrates these different services into one 'overall'-service, but it also offers many 'singular' services that also involve multiple back offices. Figure 3 provides a high-level overview of the business counter.

3.1 Liquor-License Process

A liquor license is one of the most important permits for the Hotel- and Catering Industry. Every restaurant or café that pours alcohol is obliged to apply for a license. For requesting a license, an entrepreneur can contact the business counter. After an initial intake meeting, the entrepreneur has to fill in an application form and return it together with the needed official documents, for example a floor plan. Hereafter, the name and address of the applicant are checked, the justice department and the police are asked for advice about whether the applicant has a criminal record or not. Finally, the building department has to check whether

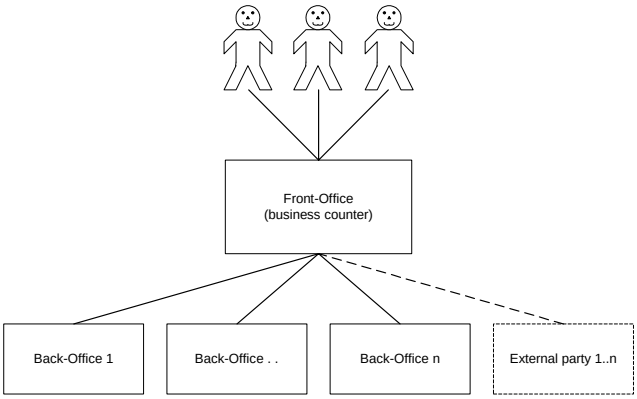

Fig. 3. High-level Overview of the Business Counter

the building meets all legal requirements and the application for a liquor-license is published in the municipal newspaper. On basis of these advices, the back-office employee draws up a license or a letter stating the reasons for refusing the license.

3.2 Web Service Orchestration at the Business Counter

Currently, the business counter functions virtually without any ICT-support, but plans to automate the service-delivery processes at the Business Counter using web service orchestration-technology are being considered. To demonstrate the potential of web service orchestration for supporting processes like the liquor-licensing process, a BPEL-prototype was built using an early version of Collaxa Orchestration Sever, now Oracle BPEL Process Manager [18]. The process that was used in this prototype was inspired on a simplified variant of the liquor-licensing process. In the prototype, the overall liquor licensing process runs on a central orchestration server at the business counter, and tasks that are to be performed by other agencies are invoked as sub-services using a web-service-interface. An example of a web service that is invoked from the main liquor-licensing process is a web service at the police that checks whether the applicant is known in their database.

3.3 Requirements for a Reference Model for Process Orchestration at the Business Counter

As a process orchestrator, the main task of the business counter is coordinating the cross-agency service-delivery processes. As can be seen in the previous section, web service orchestration offers a promising technological solution to automate these cross-agency service-delivery processes. Web service orchestration is capable of supporting the whole cross-agency service-delivery process, but

web service orchestration-technology does not solve the coordination-related issues that governmental decision-makers are currently facing when implementing process-orchestration.

Examples of the coordination issues that should be addressed by a reference model for process orchestration in e-government are ensuring the correct and in time execution of the process, information-sharing, and accountability.

Ensure Correct and In-Time Execution of the Process

As the process orchestrator is responsible for the overall service-delivery-process, one of the main coordination tasks a process orchestrator must perform is ensure that every sub-service in the cross-agency service-delivery process is completed in the right way, in time. At the business counter, for example, there is a problem guarding the lead-times of the overall liquor-licensing process, as some of the required sub-services sometimes take a long time to complete, or are even not completed at all. This way the required lead-times of the overall-process are not met.

Coordination-mechanisms like service-levels can help in ensuring correct, and in-time execution of every sub-service, but simply agreeing beforehand upon service-levels between the business counter and the different agencies is not enough. The service-levels need to be constantly monitored, and mechanisms that respond when a service fails, when a service does not produce the required answer, or does not answer in-time, should be put in place.

Information Sharing

Another coordination-related problem is the sharing of information between the different governmental agencies. When different agencies are all involved in one service-delivery process, they should all have access to the customer-data that is relevant to them. Within a single organization this can relatively easy be solved, for example by means of a large data-warehouse, but in a governmental setting, where many of the involved agencies have their own autonomy, this is not feasible. As the responsibilities are fragmented among many different governmental agencies, so are its information-systems, making information-sharing between multiple agencies even less straight-forward.

Agencies performing sub-services, need the business counter to provide them with information about the customer, as they need this data in performing the process. At the business counter, the building-department for example needs information about the applicant of the liquor-license, about the kind of restaurant it is requesting the liquor-license for, etc. This 'one-way' sharing of data is relatively straight-forward, but when different agencies start updating data that is required by other agencies, the process orchestrator should provide robust information-sharing mechanisms.

The issues of information-sharing will become even more important when the law comes into effect stating that citizens cannot be asked to provide personal data that is already available somewhere else in the government, aiming to reduce administrative burdens for citizens and businesses [1].

A major issue with information sharing is privacy. Not all agencies need all available customer information. For privacy-reasons, every agency should only have access the information he or she needs. An example is the information resulting from the check of the criminal record at the justice department. This data is not relevant for, and therefore should not be provided to other parties, such as the building department. Privacy-issues should explicitly considered when designing information-sharing mechanisms.

Accountability

Accountability is an important requirement for the whole public sector. For governmental service-delivery processes, it is especially important that the processes are transparent, non-discriminating, and consistent, and that the decisions made in the process are well motivated. Citizens and businesses do no longer accept a black-box view of the service delivery process, but want to know what steps have to reach the final decision.

Ensuring accountability for governmental service-delivery processes that run across different organizations is especially difficult, as it has to cope with different (semi-) autonomous agencies that are involved in the process. The decision not to grant a liquor license, because the police have strong suspicions against the applicant, should for example be very well motivated.

Ensuring accountability of cross-agency service-delivery processes requires specialized coordination mechanisms that ensure that the outcome of every process step is recorded, and that the overall process has run the way it was supposed to.

4 Applicability of Existing Reference Models for the Business Counter Case

The case study at the business counter provided us with an idea of the requirements for a reference model supporting governmental decision-makers in implementing process orchestration in e-government. The coordination issues that were identified in the previous section give an idea of the main issues that governmental decision-makers are facing, but are not exhaustive. This section will evaluate whether the two existing reference models meet the requirements that were identified in the previous section.

4.1 Applicability of the Workflow Reference Model

To evaluate applicability of the Workflow Reference Model, it will have to be translated into orchestration-concepts. The obvious link is on the level of with web service orchestration, instead of process orchestration. Analogous to workflow management, in web service orchestration there also exists a central 'orchestration server' to enact the process-flow. Examples are Oracle's BPEL Process Manager [18], formerly known as Collaxa Orchestration Server, Microsoft Biztalk 2004 [19], and IBM Websphere Business Integration Server Foundation

[20]. Analogous to workflow, process definition and monitoring tools are also needed. External applications can be invoked by means of their web service-interface and human tasks can be supported by invoking a web service interface to someone's e-mail client. Web service orchestration also relies on invoking web services for interfacing with other orchestration servers. A process that is defined in BPEL can be made available as a web service itself, and thus be called by a process on another orchestration server.

From this translation of the Workflow Reference Model into web service orchestration-terms can be seen that there is quite a large resemblance between workflow and web service orchestration. The coordination issues that governmental decision-makers are facing, however remain unaddressed when decision makers rely only on this reference model when implementing process orchestration for their inter-agency processes. The reference model does not indicate how to guard lead-times, or how to facilitate information-sharing. Instead, the reference model seems to focus on what technical components, and kinds of technical interfaces are needed when implementing web service orchestration. This is, analogous with the initial goal of the workflow reference model, more relevant to vendors of orchestration technology, than to governmental decision-makers.

4.2 Applicability of the Extended-SOA Reference Model

The first thing to notice when looking at the extended-SOA reference model is that this reference model is rather 'business-oriented' in its roles and functionality. The model identifies a service-provider, service-requester, service-aggregator, service-operator, and even a market maker. Several of these roles can of course be performed by the same organization, but the model seems to be more tailored to situations where service requesters buy or rent services from service-providers on a services market.

Having said this, large parts of this reference model are still relevant to the situation of implementing process orchestration at the business counter. Especially the composite services layer is very relevant, as offering a service as a liquor-license where sub-processes at different agencies are incorporated into the overall service-delivery process, is an example of composition. The managed-services-level appears to be less relevant in the case of the business counter, but may become so in the future, when web service orchestration is adopted on a larger scale.

The business counter translates to the role of service aggregator in the reference model. It aggregates services that are provided by other agencies (service-providers), and provides these aggregated services to the customer. The reference model does address many of the issues that the decision-makers are facing by means of the tasks that the service-aggregator must perform.

The functionality in the composite services layer: coordination, monitoring and conformance-checking, and agreeing on service levels of the incorporated services matches quite well the requirements that were identified at the business counter. Although it does address these issues, it does not provide guidelines about how to fill them in. Decision makers can use this reference model only to

identify the roles and functionality that they need to consider, but will have to fill these in themselves.

5 Conclusions

The goal of this paper is to investigate the applicability of two existing reference models to governmental decision-makers for implementing process orchestration in e-government, based on requirements for a reference model identified at a case study.

The case study showed that governmental decision-makers are looking for support in designing coordination related mechanisms like ensuring the correct and in-time execution of the process, information sharing, and accountability.

When comparing the both reference models to these requirements, it is clear that neither one can provide governmental decision-makers with enough support. The workflow reference model is too much focussed on technology, and therefore fails to address the non-technical coordination issues, and although the e-SOA reference model does address many of the issues, the model remains rather descriptive, only pinpointing the required functionality, but not indicating how this should be filled in.

To support governmental decision makers in implementing process orchestration in e-government, a new reference model is needed, focussing on the role of a process orchestrator, and prescribing how this role can be best filled in with respect to the needed coordination mechanisms. Further research will focus on designing such a reference model.

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