Dynamic Composition of Workflows for Customized eGovernment Service Delivery

Soon Ae Chun, Vijayalakshmi Atluri and Nabil R. Adam
MSIS Department and CIMIC, Rutgers University, Newark NJ 07102
{soon,atluri,adam}@cimic.rutgers.edu

Abstract

Today, many government agencies provide tremendous amount of information and services via the Web, often overwhelming the citizens. Personalization and customization in delivering information and government services remains as a major challenge. In this paper, we present a novel approach for dynamically composing workflows to delivering customized government services to citizens. Such a system is especially important in a government service delivery due to the fact that many autonomous government agencies are involved in providing parts of this service. As a consequence, citizens are often required to first identify these components of the desired service and contact the agencies independently to obtain the needed services. Our proposed system dynamically composes the inter-agency service as well as the related information, tailored to needs of a citizen, by identifying, integrating and coordinating individual components that constitute this service. Our system achieves customized generation of workflows by specifying governmental regulations as a Condition-Action Rule Base to identify the component services. The rule base is a collection of statements about regulatory, functional, geographical and temporal regulations that an inter-agency service needs to adhere to. Our prototype system which also includes visualization of the regulations along with the customization, has been submitted as System Demo paper to this workshop.

1 Introduction

With the proliferation of easy-to-use Internet and Web technology, many federal, state and local governments now provide the necessary instructions and forms for specific services. This facilitates citizens with direct interaction with the desired government service. However, this first phase of digital government efforts has resulted in a fragmented conglomeration of services and information sources. This gives raise to a number of problems: (1) Citizens are expected to identify the necessary government services, and extract the relevant requirements for receiving these services. The relevant piece of information may be hard to locate. In other words, the expert knowledge about what regulatory rules apply for obtaining a service and how to obtain the requisite information is now expected from an average citizen. (2) Often government services span agency boundaries that require services from not just one agency but from several. For example, new business registration services [Adam et al., 2001] may require services from Department of Commerce, Department of Revenue, Division of Commercial Recording, Division of Community Affairs, Department of Environmental Protection, Department of Public Health and Safety, Division of Unemployment and Disability Insurance, Div. of Worker's Compensation and many more (c.f. welfare and social benefit services [Bouguettaya et al., 2001]). To provide a cohesive, seemless and comprehensive inter-agency and inter-governmental service to the citizen, service integration and automation across several agency-specific stove-pipe systems is essential. (3) Citizens are expected to interact with each agency independently by first acquiring the knowledge of the interdependencies among different component services.

To address these issues, in this paper, we have proposed an approach that can automatically generate an inter-agency service, called *inter-agency workflow*, that is tailored to the individual preferences of the citizens. Our inter-agency workflow system assumes a component-based composition model where loosely coupled agency services serve as basic components to be integrated into an inter-agency workflow. Our system achieves service automation by coordinating participating agencies' services and information, while maintaining autonomy of each agency's operation and information systems [Alturi et al., 2001, Chun et al., 2002]. Figure 1 depicts component services to register a new business in the State of New Jersey, ranging from local, state and federal levels,

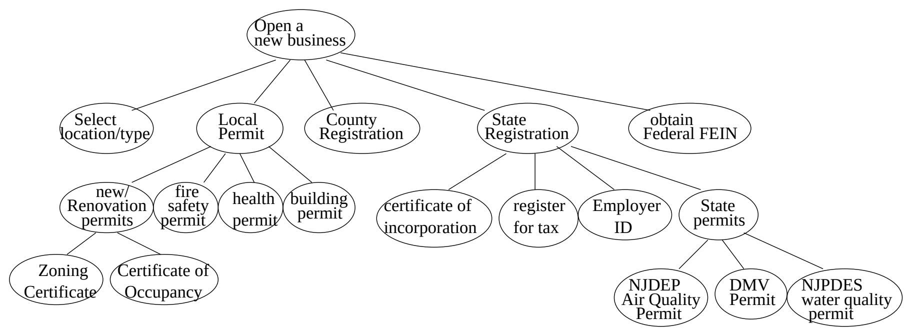

Figure 1: Component Services for opening a new business

The composition of the inter-agency service needs to be dynamic, but not static, and automatic rather than manual, to deal with diverse situations and contexts of each citizen. For example, the requisite component services in the New Jersey business registration process vary from case to case, depending on the type, location and structure of each business, as illustrated in the following example.

Example 1 Assume, an entrepreneur John Smith wishes to start a new auto body repair facility in New Jersey, and another entrepreneur Jane Carlson wishes to open a convenience store. John Smith wants to locate his business in downtown Newark, Essex county, while Jane Carlson wants to have her shop near her home in Mercer county. John wants to have the business incorporated with several employees, while Jane wants to have it as a sole proprietorship without any employees.

According to the requirements, two different inter-agency service specifications are needed as shown in figures (2a) and (2b) for John and Jane, respectively. While both entrepreneurs need to file the tax-related business registration application at the Division of Taxation, their required steps and tasks differ. John will need to obtain a certificate of incorporation and employee related insurance as well as an air quality permit, while Jane does not have to go through these component services. □

As can be seen, the steps (component services) involved in an inter-agency workflow vary to a large extent, even though they are part of the same process. As such, it is not feasible to specify all these different cases at design time in a single service specification. In this paper, we present our system that can *dynamically compose* a *customized workflow* tailored to the services needed

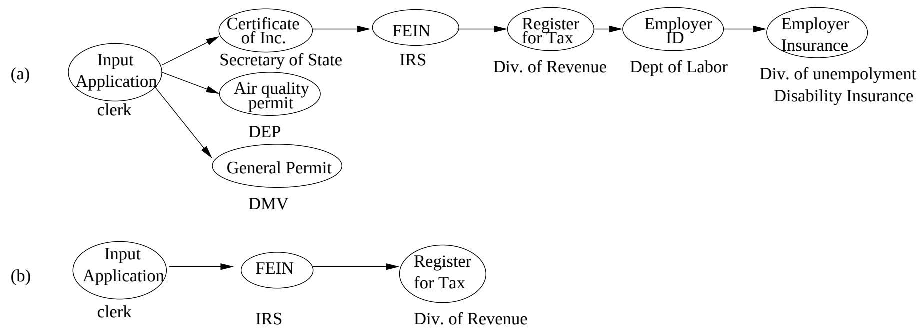

Figure 2: Customized business registration process

for each applicant. Our system uses a rule base comprising of a collection of regulatory and other requirements that each applicant needs to comply with, a set of applicants' profiles, and a set of services that are offered by various agencies.

2 Customized Workflow Generation

Our methodology for the interagency service integration and coordination is to use the domain knowledge implicitly and explicitly required for the service composition. In order to discover appropriate tasks (services) in coordinated sequence, citizens require the following descriptive domain knowledge: (1) an interagency service/process ontology, (2) a domain-specific regulatory ontology, (3) expert's compositional knowledge, including control and coordination knowledge. A system equipped with the domain knowledge and procedural knowledge is able to automate the workflow generation. The system frees an ordinary citizen from the burden of identifying various requirements, and delivers a customized workflow. Our workflow generation model based on the knowledge-based method is reported in [Chun et al., 2002].

2.1 Service Customization Rules

Federal and state regulations may require a new business owner to obtain certain registrations, approvals, permits, and certificates from authorized agencies, such as the New Jersey Department of Environmental Protection (NJDEP), the Department of Revenue, the Department of Taxation, *etc*. These may differ based on the location, the types of materials stored and used, potential emissions of discharges, *etc*.

Following are the examples of different types of regulatory rules:

1. Semantic Rules: These are the rules that affect the contents or activities involved in workflows and tasks. For example, an environmental protection regulation states that any business type, such as an autobody shop, that releases a certain level of spray paint into the air is required to obtain an air quality permit.

2. Spatial Rules: These are concerned with the location and other geographic features of the business [Holowczak et al., 2001]. Some examples include: (1) If a development project or facility includes construction, installation or alteration of a structure along, in, or across the

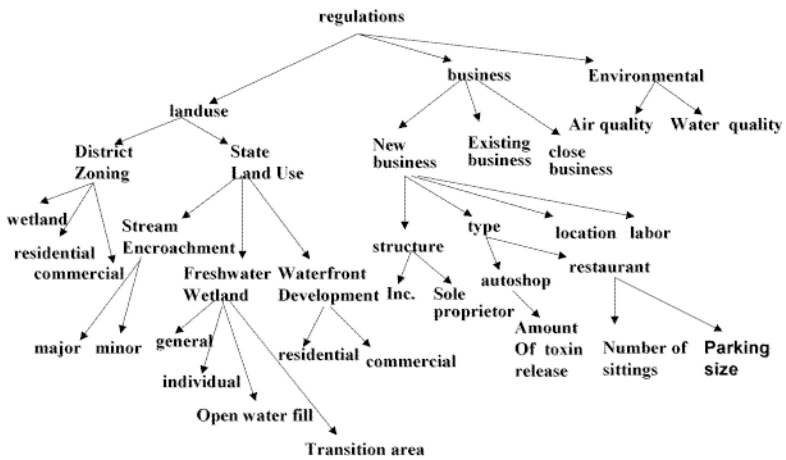

Figure 3: Ontology of Government Regulations

stream channel, or 100 year flood plain of any stream, then a stream encroachment permit is required. (2) If a business project is located in municipalities under a certain agency jurisdiction, then a development application needs to be filed and approved by that agency.

3. Temporal Rules: Temporal rules state the absolute and relative deadlines associated with a task. For instance, if a public records filing for a new business entity is submitted, then tax registration forms must be submitted within 60 days of filing the new business entity.

4. Sequencing Rules: These rules specify the obligatory sequence among tasks. For example, obtaining a certificate of incorporation is required before business registration, and business name availability must be checked after business name reservation is done.

Identification of appropriate services is based on these government regulations. We use an ontology to model concepts and relationships of these regulations. It is a conceptual hierarchy categorized into different topics (or types). Figure 3 shows an example of land use related regulations, business related regulations, and environment related regulations. At the leaf concept nodes, the regulatory rules are attached. These rules are represented as a set of *Condition-Action* rules as shown in tables 2 and 3.

2.2 User Profile Gathering

We assume that the set of user profile attributes are hierarchically organized. The profile attribute data required for registering a new business in the State of New Jersey is shown in figure 4, which include business structure, location, name, type and employee information, such as payroll and number of employees. A leaf node represents an attribute that assumes a value. For instance, the attribute *structure* can take a value from the set {incorporated, sole proprietorship, limited partnership,...}. This hierarchical profile organization can be easily represented as a set of profile rewrite rules as shown in table 1. These profile rewrite rules are used to gather profile information by dynamically expanding the LHS of a rule with children nodes and collapsing children nodes when all the attributes are filled with values. The profile rewrite rules are ordered such that the profile

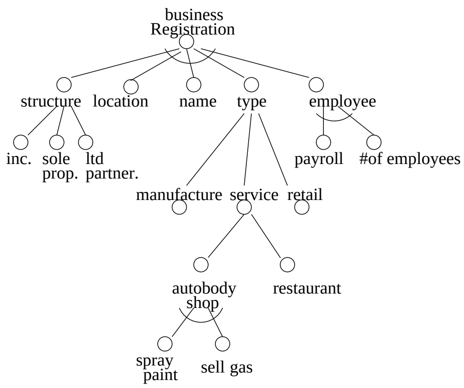

Figure 4: Profile Attribute Hierarchy

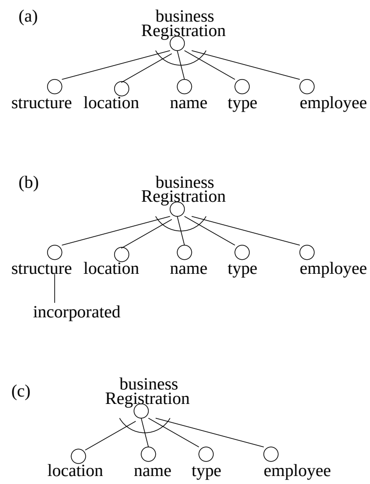

Figure 5: Tree Structure for Profile Evaluation

P1: $business\ registration \rightarrow structure \wedge location \wedge name \wedge type \wedge employee$
P2: $structure \rightarrow incorporated$
P3: $structure \rightarrow sole\ proprietorship$
P4: $location \rightarrow street \wedge county \wedge state \wedge zip$
P5: $type \rightarrow manufacture$
P6: $type \rightarrow service$
P7: $service \rightarrow autobody\ repair$
P8: $autobody\ repair \rightarrow amount(spray\ paint) \geq 1/2\ gallonhr \wedge sell\ gas$
P9: $employee \rightarrow payroll \geq \$1000 \wedge number(employee) \geq 1$

Table 1: Profile Rewrite Rules

information is gathered in the correct order. Figures 5(a-c) illustrate the expansion and shrinkage of the tree structure as the profile information is gathered, which is explained below. When the business registration is requested, the rewrite rule P1 is triggered and expands the children nodes as in (a), which means the user needs to provide values for these attributes; Next, either P2 or P3 can be triggered for the attribute $structure$. In our example, P2 is used as in (b). Once its value for $incorporated$ is supplied by a user, the tree shrinks, eliminating the node for the attribute $structure$. Then the next attribute, $location$, needs to obtain a value, as shown in (c), and so on. For brevity, the rest of dynamic development of profile tree is not shown here.

2.3 Dynamic Composition of Customized Workflows

Given a set of customization rules and a user profile, the customization process generates an individualized workflow, selecting only relevant component services (i.e. tasks) and obeying other constraints such as sequence ordering rules. Given the customization rule base shown in tables 2-3, and the user profile gathered through the user profile gathering procedure described in the previous section, the customization process activates rules and automatically selects tasks, and arranges these tasks according to the coordination rules. For instance, when a user enters $incorporated$ as his business structure, the system finds the rule R1 in table 2, and inserts $t1$ and $t2$ into the workflow. Here, we assume *t1 = register business name with the State of NJ*, *t2=file original business certificate*, and *t3=register business's name with the County Clerk*. On the other hand, if the user prefers to estab-

R1: $< struct = incorporated, insert(t1) \wedge insert(t2) >$
R2: $< struct = limited\, liabilitycompany, insert(t1) \wedge insert(t2) >$
R3: $< struct = limited\, partnership, insert(t1) \wedge insert(t2) >$
R4: $< struct = limited\, liability\, partnership, insert(t1) \wedge insert(t2) >$
R5: $< struct = sole\, proprietorship, insert(t3) >$
R6: $< struct = general\, partnership, insert(t3) >$
R7: $< register\, business, register\, business\, for\, tax >$
R8: $< register\, business, obtain\, federal\, employer\, id >$

Table 2: Selection Rules

R9: $< register\, business, certificate\, of\, incorporation \prec register\, business\, for\, tax >$
R10: $< register\, business, fein \prec register\, business\, for\, tax >$
R11: $< register\, business, register\, business\, for\, tax \prec employee\, insurance >$

Table 3: Ordering Rules

lish a business of $sole\, proprietorship$, then R5 fires. As a result, $t3$ is inserted into the workflow. As soon as a rule fires, the profile evaluation tree shrinks, and the next profile attribute evaluation starts, as shown in figure 5. This process of evaluating rules with profile information repeats until all the attributes of the profile tree acquire values and are used to fire appropriate rules. The end result of this repetitive process of rule evaluation is a set of tasks that constitutes the workflow.

In addition to the tasks selected based on a user's preferences, there exist other obligatory tasks required for all users irrespective of their preferences. For instance, the task *register-business-for-tax* is required for all applicants in the business registration process. These obligatory tasks are also inserted by a set of rules such as R7 and R8 in table 2.

All the tasks in the workflow are then subjected to the inter-task sequencing and ordering rules and other inter-dependency rules to ensure the coordination requirements. Some examples of these rules are presented in table 3. For instance, rule R9 states that if the process is *register business*, then the task of the *obtain a certificate of incorporation* should be finished before the task *register business for tax*.

In summary, the rule base comprises of preference rules, obligatory rules and coordination (or sequencing) rules. We have shown that the government regulations provide service selection and control knowledge needed in the dynamic service integration. We demonstrate [Adam et al., 2002] a web-based interactive map system to visualize customized geospatial regulatory rules, i.e. rules that are relevant only to a specific business type a user has chosen.

3 Related Work

Industry and research activities to expidiate the discovery and integration of web services and applications on the web revolves around XML-based standards for service descriptions and service registry, such as WSDL, UDDI and ebXML. They focus on service discovery and advertisement, but lack discussion on how the services are automatically glued together. Platforms for developing composite e-services proposed in [Schuster et al., 2000, Casati et al., 2000, Karp, 2000, Benatallah et al., 2000] have limited functionalities to provide runtime composition options. Our approach utilizes the government regulations as composition rules to discover the appropriate component services and dynamically compose them into an integrated inter-agency workflow, resulting in a customized service.

4 Conclusions and Future Work

We have presented a component-based inter-agency workflow customization system that can dynamically adapt to user preferences, and automatically select component services based on regulatory and coordination rules. Our implementation for inter-agency workflow employs XML to specify agency services, user profiles and regulatory rules (not included in this paper due to space limitations). We plan to extend our design-level workflow customization to the execution-level workflow customization [Adam et al., 2001, Alturi et al., 2002], that considers the dynamic execution environment and agency-specific preferences (agency profile), thereby allowing the flexible adaptation to dynamic changes in the execution environment and customization according to agency-specific execution profiles.

Acknowledgement

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References

[Adam et al., 2001] Adam, N., Artigas, F., Atluri, V., Chun, S., Colbert, S., Degeratu, M., Ebeid, A., Hatzivassiloglou, V., Holowczak, R., Marcopolus, O., Mazzoleni, P., and Rayner, W. (2001). E-government: Human centered systems for business services. In *The First National Conference on Digital Government*, pages 48–55.

[Adam et al., 2002] Adam, N., Artigas, F., Atluri, V., Chun, S., and Mazzoleni, P. (2002). Customized visualization of geospatial government regulations. In *this volume*.

[Alturi et al., 2002] Alturi, V., Chun, S., Holowczak, R., and Adam, N. (2002). Automating the Delivery of Governmental Business Services Through Workflow Technology. In *Advances in Digital Government:Technology, Human Factors, and Policy*. Kluwer Academic Publishers. (in press).

[Alturi et al., 2001] Alturi, V., Chun, S., and Mazzoleni, P. (2001). A Chinese Wall Secuity Model for Decentralized Workflow Systems. In *Eighth ACM Conference on Computer and Communications Security (CCS-8)*, Philadelphia, Pennsylvania, USA.

[Benatallah et al., 2000] Benatallah, B., Medjahed, B., Bouguettaya, A., Elmagarmid, A., and Beard, J. (2000). Webbis: A system for building and managing web-based virtual enterprises. In *Proceedings of the First Worksho on Technologies for E-Services, in cooperation with VLDB2000*, Cairo, Egypt.

[Bouguettaya et al., 2001] Bouguettaya, A., Elmagarmid, A., Madjahed, B., and Quzzani, M. (2001). A web-based architecture for government databases and services. In *The First National Conference on Digital Government*, pages 56–59.

[Casati et al., 2000] Casati, F., Ilnicki, S., and Jin, L.-J. (2000). eflow: a platform for developing and managing composite eservices. Technical report, HP Laboratories Palo Alto.

[Chun et al., 2002] Chun, S. A., Atluri, V., and Adam, N. R. (2002). Domain knowledge-based automatic workflow generation. (submitted for publication).

[Holowczak et al., 2001] Holowczak, R., Chun, S., Artigas, F., and Atluri, V. (2001). Customized geospatial workflows for e-government services. In *ACM-GIS 2001, The Ninth ACM International Symposium on Advances in Geographic Information Systems*, Atlanta, GA, USA.

[Karp, 2000] Karp, A. (2000). E-speak e-xplained. Technical report, HP Laboratories Palo Alto.

[Schuster et al., 2000] Schuster, H., Georgakopoulos, D., Cichocki, A., and Baker, D. (2000). Modeling and composing service-based and reference process-based multi-enterprise processes. In *Proceedings of the Inernational Conference on Advanced Information Systems Engineering (CAiSE)*, Stockholem, Sweden.