Client-side Service Composition Using Generic Service Representative

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Abstract

Traditionally, composition of web services are performed at the server-side. This requires transferring client data among collaborating web services which may cause data privacy and security breaches, or network traffic overloading. In this context, we introduce the concept of "task service" which is a web service that can process the client data locally at the client-side using a generic software agent that we call "service representative". The proposed task service and service representative allow us to present a new concept "client-side service composition" where collaborating web services employ the service representative to provide a composite task service at the client side. Therefore the client is not required to reveal its resources and hence its privacy and security are maintained. Moreover, large client data are processed locally that causes less network traffic. We have developed a prototype system for the proposed extended SOA model. We will discuss the advantages of the proposed approach over traditional server-side approaches using a case study in the healthcare domain.

1 Introduction

In Service Oriented Architecture (SOA) the business functionality of an enterprise is modeled by web services. To achieve more sophisticated functionality, web services should be reusable and composable. Different approaches have been proposed to address web service composition either statically at design time or dynamically at run time. Business Process Execution Language (BPEL) is an industry-wide standard that models a business process based on collaborating web services. Moreover, the BPEL process is provided as a composite web service that can be called by a service client.

A traditional simple or composite web service processes client's request completely at the server-side that requires the client to send its data as the service parameters to the service provider. On the other hand, there are several cases in the business domain that the client data should be processed locally at the client-side such as:

- Client data is confidential and revealing it to a service provider violates the client's privacy and security.
- Client data is large or changes over time, thus transferring it to a service provider increases the required bandwidth.
- Real-time and time-critical services, where transferring client data to a service provider increases the response time.

Since, traditional web services lack the ability of client-side processing, they fail to provide an efficient and secure way to model these services. As a solution, a service provider can customize a software agent and send it as its service response to process client data locally. However, this solution increases the net-

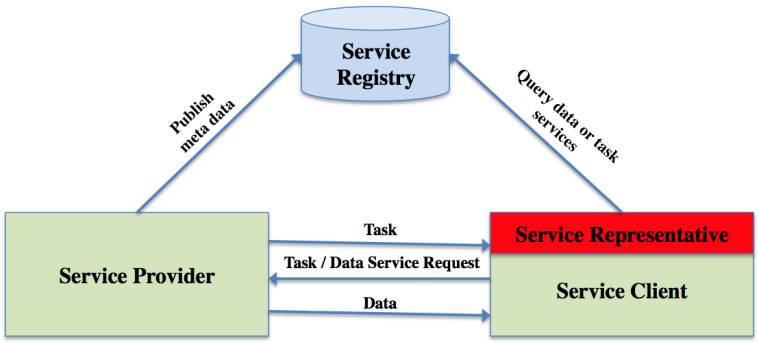


Figure 1: The proposed extended SOA reference model, where "Service Representative" processes client data based on an assigned "Task" from the service provider.

work traffic and introduces security and privacy problems. As an alternative, we propose a generic software agent that is located at the client side and can be customized and trained with the service messages to perform a task (i.e., processing client's data). We define this generic agent as *Service Representative*, and the type of services that require client-side processing as *Task Services*. Figure 1 shows the extended SOA reference model to support task services. Furthermore, we extend the notion of task services and service representatives to perform composite tasks at the client side. Consequently, client data are processed at the client side and web services are composed via the service representative. As the result, the proposed model improves the current state of SOA in terms of maintaining the client privacy and security, reducing the network traffic as well as improving the web service interoperability.

The organization of this paper is as follows. Task services are introduced in Section 2. Client-side service composition is described in Section 3. The proposed architecture and its details are discussed in Section 4. The developed prototype system is described in Section 5. A case study of composite task services is presented in Section 6. Section 7 presents the related work to our approach. Finally, conclusions and future work are discussed in Section 8.

2 Task Service

Data service represents a typical web service that receives client data, processes it entirely at the server-side, and returns the results as the service response to the client. The service response will be consumed directly by the client.

Task service represents a new type of web services that process client data partially or completely at the client-side. According to the client's request, a task service first performs the required server-side processing and then it defines a task for the generic service representative to perform the client-side processing. The task will be executed at the client-side and the client will use the task result as the service response. A task service returns a task message to the client-side with the following components:

$$Task =< Model, Knowledge, Data >$$

- *Task Model* specifies a task using an abstract Business Process Model (BPM).
- *Task Knowledge* provides the required Business Rules (BR) and Business Actions (BA) to realize the specified BPM.
- *Task Data* represent Business Objects (BO) that are consumed by the business rules and actions during the business process. Task data consists of two parts: server-side (provided by the service provider) and client-side (provided locally by the service client).

Service representative is a generic and client-side software agent that can be employed by a

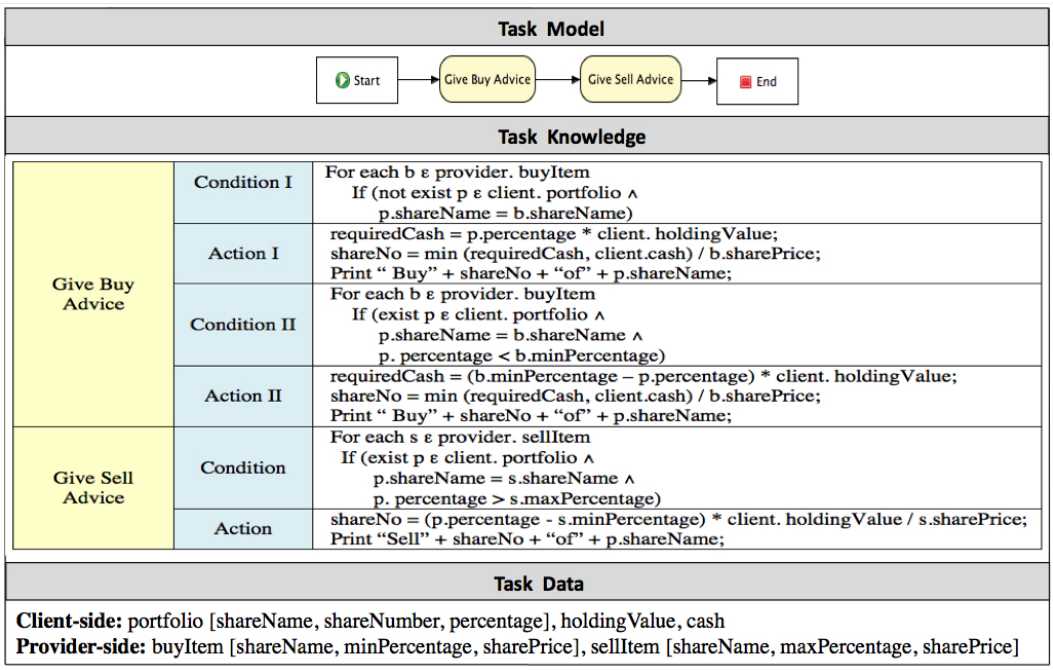


Figure 2: A task service to personalize general financial advice based on the client personal information at the client site. Conditions are expressed using First Order Logic (FOL) and actions are defined using Java statements. In each step of the task model, the corresponding rules and actions are applied.

service provider to perform different task services. For this purpose, the service representative uses the received task components to customize and train itself in order to perform the client-side processing of the web service on the client data (i.e., client-side task data). Task components are messages that can be transmitted efficiently over the network. Consequently, the proposed "generic service representative and its assigned task" relieve a service provider from sending the entire "specialized agent" each time. Moreover, the client determines both the local data that the service representative can access and the computer resources (e.g., CPU time, storage, and memory) that the service representative requires. Therefore processing client data using service representative improves the security, privacy, and efficiency features of traditional web services (data services) and mobile agent approaches.

Figure 2 illustrates different components of a task service that provides personalized financial advice without asking the client to send its personal information. This service receives client's general preferences such as: category of investment (stock, option, or mutual fund); term duration (short term or long term); and risk level (low, medium, or high). However, the client keeps the sensitive information local and private, such as financial information (portfolio, saving, debt, and salary). This task service has both server-side and client-side processing as follows.

- *Server-side processing*: the service provider generates a set of general financial advice (e.g., stock buy and sell advice) according to the client's preferences. Moreover, it specifies a task for the service representative to personalize the generated general advice based on the local client's financial information.

- *Client-side processing*: service representative receives the task, which allows it to customize and train itself in order to perform the task. According to the task

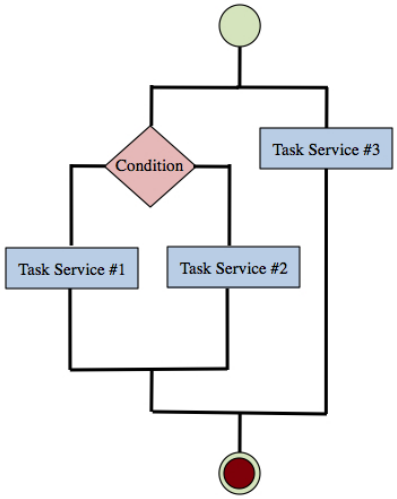


Figure 3: An example of a composite task service.

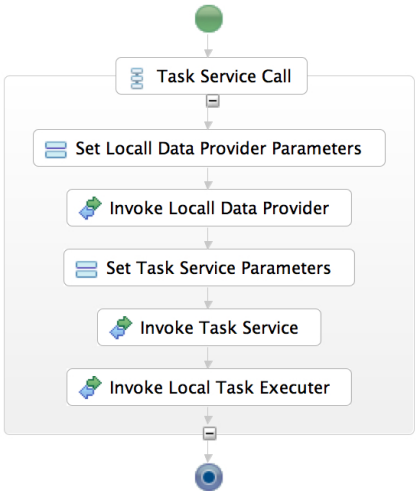


Figure 4: The required step for invoking a task service in a BPEL model.

model, service representative applies *Give Buy Advice* and *Give Sell Advice* business rules on both client-side and server-side task data and returns the generated personalized advice as the service response to the client.

3 Composite Task Service

In the context of our approach, "client-side composite task service" (or simply composite task service) is defined as a combination of task services over a designated flow structure that is performed by the service representative at the client side. The service representative plays the role of a service orchestrator that coordinates the execution of the involved web services (both data and task services). The incorporating web services are not aware that they are taking part in a higher-level business process. An example of a composite task service is shown in Figure 3.

For each composite task service, the corresponding "composite task model" and "task data schema" are published on the service registry. The client obtains the service description from the service registry. The client forwards the composite task model to the service representative, and uses the task data schema to provide the required client-side task data to the service representative. The service representative calls each involved task service according to the model and uses the received task message to customize and train itself to execute that task. Each executed task modifies the client data that are made available to the service representative, which collectively represent the service provided to the client by the composite task service.

3.1 Composite Task Model

A campsite task model specifies the exact order in which participating task services should be invoked, either sequentially or in parallel. Moreover, conditional behaviors can be expressed.

We use BPEL to model a composite task service that allows us to define complex business processes in an algorithmic manner including loops, variables, and fault handlers. We consider two local services for the service representative: *local data provider* to read client data and *local task executor* to execute a received task. The required steps to call and execute a task service are shown in Figure 4.

3.2 Client-side vs Server-side Service Composition

The proposed client-side service composition approach does not intend to replace the traditional server-side service composition. However, when collaborating web services require processing confidential, large, or dynamic client resources, composing them at the client side can improve the following SOA features.

- *Privacy*: the confidential and sensitive client data are kept local and processed at the client side.
- *Security*: the service representative functionality is under client control and it can not perform malicious behavior.
- *Interoperability*: task services can be composed efficiently using well-known forms of task model, knowledge, and data.
- *Efficiency*: large client data are processed locally that reduces the required bandwidth.
- *Response Time*: realtime and variable data are processed offline that reduces the response time.

4 Architecture

In order to develop task services that are executed and composed by the service representative an architecture is required. In this section, we extend the typical architecture of SOA implementations to enable service providers to employ the generic service representative at the client side. The proposed architecture (Figure 5) includes three main components as follows.

4.1 Service Client

Each service client (or "client" for short) consists of a client application and a communication channel as follows.

Client Application. It is a traditional client application that sends a data or task service request to a service provider. Moreover, the client application puts the required client data for a task service into a communication channel based on the schema received from the service registry. The client application receives the service response directly from the service provider (data services) or indirectly from the service representative (task services).

Communication Channel. It consists of a number of ports that are connection links to the client data, as well as the means for the client application to receive the task service result through the service representative. The client grants permission to the service representative to read/write a number of its data through these ports where ports can be input, output, or bi-directional (from the client point's of view). Moreover, each port is assigned a scope as public or private. The content of a public port can be sent to a service provider as service parameter while the content of a private port can only be used locally by the service representative. In addition to typical descriptions for data services, the service registry must include the required communication channel schema for each task service.

4.2 Service Provider

An enterprise system provides a number of services for its client where each service executes one or more business processes of the enterprise. Each business process applies business rules and performs business actions on internal (server-side) and external (client-side) business objects in a defined order. Therefore, an enterprise can be modeled by a collection of business components which are business processes, rules, actions, and objects. On the other hand, a business process can have server-side and/or client-side processing. Accordingly the proposed service provider has two layers: processing layer performs the server-side processing of a web service while the task layer defines a task for the service representative to perform the client-side processing of the web service at the client side. Therefore, the enterprise business components are divided between these two layers. While, the processing layer applies the business components, the task layer sends them to the client-side to be applied by the service representative.

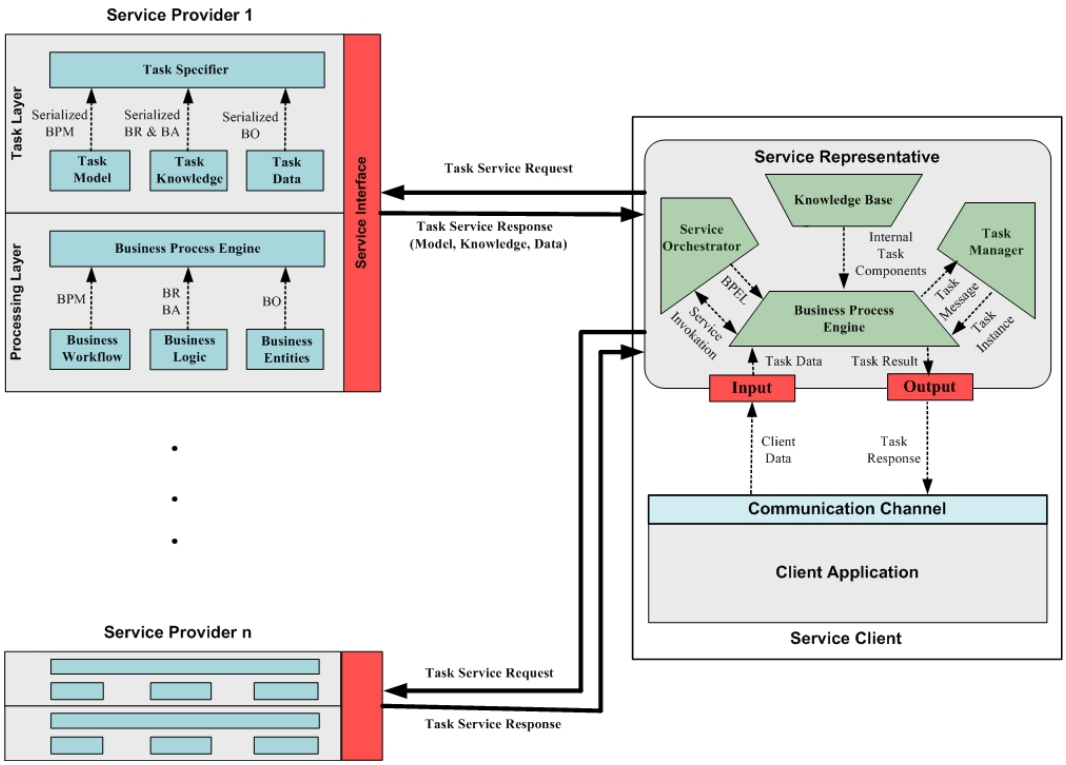


Figure 5: Proposed extended SOA architecture to perform a client-side service composition. Each service partner generates a three-segment task message to customize the generic service representative to perform a sub task of the composite task.

Service Interface. It supports the communication contracts (message-based communication, formats, protocols, security, exceptions, and so on) for the services.

Processing Layer. Server-side business processes, rules and actions, and objects are stored into the business workflow, logic, and entities components, respectively. The business process engine executes the corresponding business process with each service. If the service only requires server-side processing, this layer responds to the client by a single-segment response message (i.e., called data message). Moreover, the business process engine can modify the business components in the task layer, if the requested task depends on the server-side processing.

Task Layer. Client-side business processes, rules and actions, and objects are stored into the task model, knowledge, and data components, respectively. Since, business components in this layer are sent to the client side, they must be serializable. Task specifier provides the required model, knowledge, and data for each task request to be sent by a three-segment response message (i.e., called task message) to the client.

4.3 Service Representative

The proposed service representative is modeled by a software agent whose components are introduced below.

- *Input*: inputs client data through the communication channel.
- *Output*: outputs task response to the client through the communication channel.
- *Knowledge Base*: stores internal and domain-based business rules and actions

to relieve the service provider from sending them each time.

- *Business Process Engine*: executes a task instance by applying business rules and performing business actions. Moreover, it executes BPEL processes representing composite task models.

- *Task Manager*: supports the entire life cycle of a task instance (i.e., from creation to termination) that is divided into three phases as follows.

    1. *Customization phase*: sets up the agent configuration (including inputs and outputs) based on the service description published on the service registry and creates an abstract process based on the model segment of a received task message.
    2. *Training phase*: generates a task instance from the abstract process using internal and external task knowledge.
    3. *Execution phase*: passes the task instance with the relevant task data (i.e., received from the input component and task data segment) to the business process engine to be executed. Finally, service representative passes the task results to its outputs to be passed to the communication channel.

- *Service Orchestrator*: supports the client-side service composition as follows.

    1. Creates a communication port (i.e., a service stub) for each collaborating service as well as the local services based on the composite task model.
    2. Sends the BPEL model to the business process engine to be executed.
    3. Business process engine invokes service partners through the service stub; the received task messages will be given to the task manager to perform the client-side processing.

5 Prototype System

To evaluate the effectiveness and feasibility of our model, we developed a prototype system of the proposed architecture including the service representative, two-layer service provider, and service client. This prototype, namely *Enterprise Representative version 1.1* (EntRep v1.1), is implemented based on J2EE 1.5 technologies and Apache tomcat 6.0 application server. As Business Process Engine, service representative includes Apache ODE 1.2 to run BPEL process and Drools 5 to apply business rules and execute business actions. Moreover, communication channel is implemented by an array where each of its ports has a pointer to client data stored in a MySQL database.

EntRep v1.1 supports production rules as the form of task knowledge where each business rule is defined as follows:

when
$< conditions >$
then
$< actions >$

Conditions can be expressed by First Order Logic or SQL, and *actions* are defined using a Java function or inline Java code. Drools APIs are used by the service provider to design business process models (task model) and define business rules and actions (task knowledge). Moreover, Drools rule engine matches task data against production rules in a defined order to infer conclusions, which result in actions based on forward chaining strategy. EntRep v1.1 encodes these rules by PMML (Predictive Model Markup Language) v3.0 [7] to be sent to the client side. EntRep v1.1 is provided as two Java packages: *TaskService* and *ServiceRep* that can be imported into any service provider and client applications as follows.

- **TaskService** package: provides graphical APIs and widgets for a service developer to develop a task service where the developer just needs to define the task components using APIs in this package.

- **ServiceRep** package: provides APIs for a client application developer to call a task service. The developer just needs to create one instance of the service representative and communication channel and then

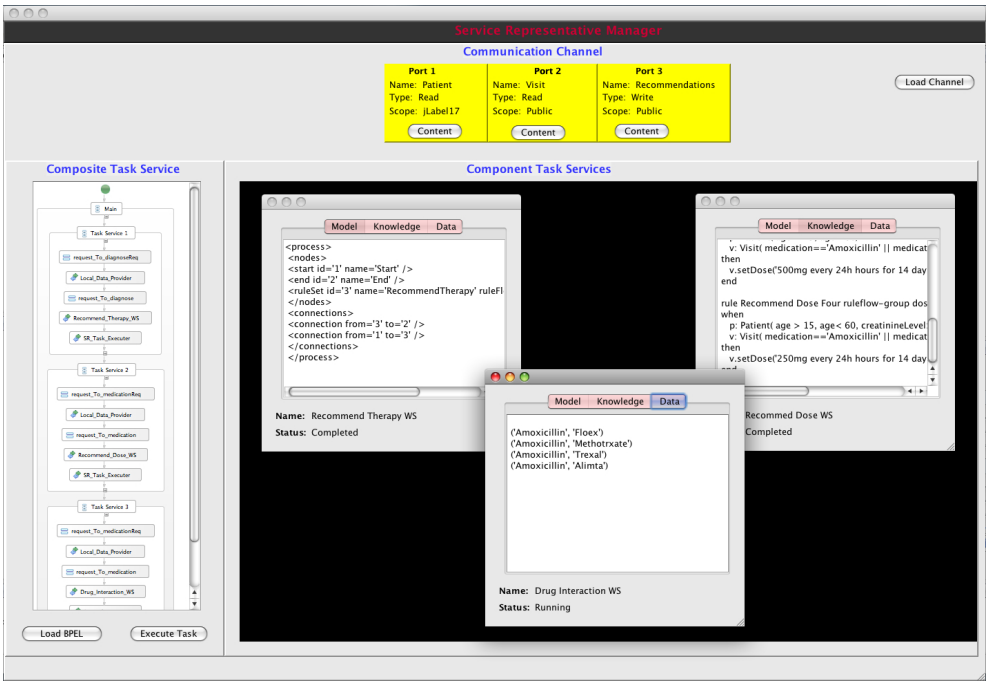


Figure 6: A snapshot of the prototype service representative manager that is running a composite task services

passes the client data into the channel according to the schema that is obtained from the service registry.

We also developed Service Representative Manager v1.1, using ServiceRep APIs, to control different phases of a composite task execution. The client can view the content of each port within the communication channel during the task execution. Figure 6 illustrates a snapshot of the Service Representative Manager executing a sample composite task service. Since the service representative is defined as a generic agent, it can be used in different task services without requiring any change to its design and implementation.

6 Case Study

There are two types of Clinical Decision Support Services (CDSS): guideline-based and model-based [8]. A guideline-based approach takes patient information and matches it with the patterns obtained from medical experiments and observations. A model-based approach initially builds a decision model according to the seen data and then applies this model on the unseen data. Since, each approach has advantages and limitations, a combined approach could lead to a more accurate diagnosis.

CDSSs cannot be developed efficiently and securely using traditional web services due to the following reasons. Guideline-based approaches require transferring patient's health information while they are highly sensitive and disclosure of this information would identify patients. On the other hand, model-based approaches do not consider local data to build their decision models. Consequently, the obtained model may not be matched with the client data. However, the local data is large to be transferred efficiently to the services.

Using the proposed methodology and implemented tool (EntRep version 1.1), we modeled and developed a secure and context-aware CDSS by a composite task service. While the client passes patient health information (as client data) to the communication channel, the service representative generates both model-based and guideline-based recommenda-

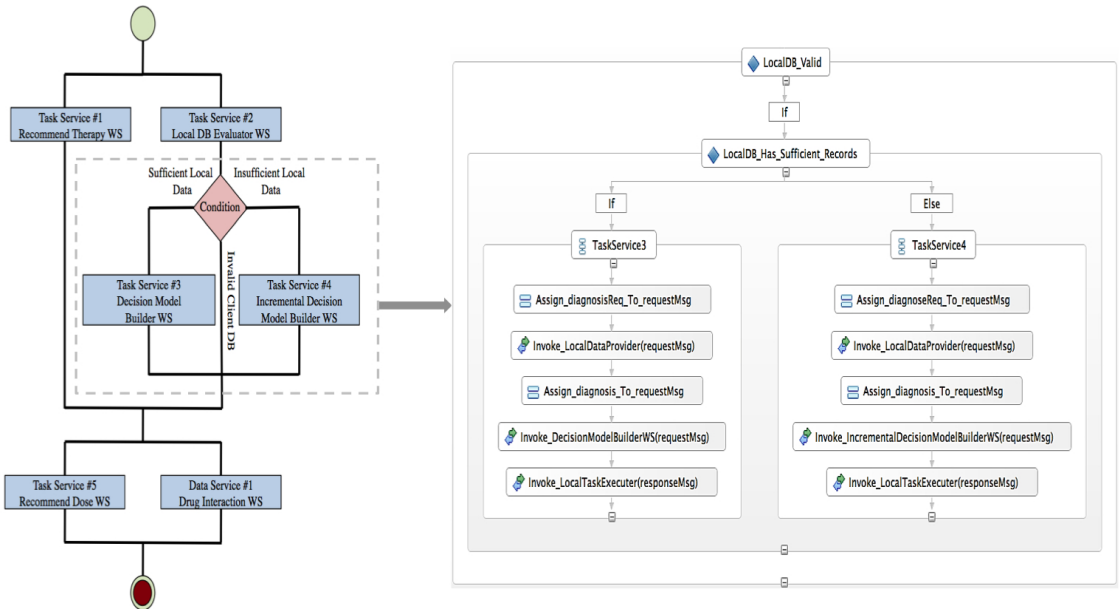


Figure 7: Composite task model (left) and the corresponding BPEL model (right) of the secure and context-aware CDSS.

tions without the mentioned problems. The composite task is shown in Figure 7 and discussed in the following subsections.

6.1 Service Client

The client puts its data and resources into the communication channel (Figure 8) with the following ports.

1. *Patient health record* (private, read only): contains the health information of the target patient.

2. *Visit information* (public, read only): contains the information that a physician gathers by visiting the target patient. The medication and dose fields are filled by the physician after consulting with the service representative.

3. *Patient database* (private, read only): contains the patients health records within the organization.

4. *Visit database* (private, read only): contains visit information of different patients collected by the healthcare organization or the physicians.

5. *Recommendations* (private, write only): receives i) recommended medication: guideline-based (gMedicataion) and model-based (mMedication), ii) proper dosage: guideline-based (gDose) and model-based (mDose), and iii) drug to drug interaction warnings from the service representative.

6.2 Collaborating Services

The composite task model includes five task services and one data service, as follows:

1. *Recommend Therapy* (task service): receives diagnosis report and returns the corresponding medications guidelines.

2. *Database Checker* (task service): receives a database schema and returns a task to verify whether the client database matches with this schema. Moreover, this task reports some statistical information about the local database.

3. *Decision Model Builder* (task service): receives a diagnosis report and returns a task to build and apply a decision model

Patient	Visit	Patient DB	Visit DB	Recommendation
- name - age - weight - creatinine level - allergies - active medications	- patient name - date - diagnosis - medication - dose	Each row contains one patient record	Each row contains one visit record	- mMedication - gMedication - mDose - gDose - warning

Figure 8: Communication channel schema for the secure and context-aware CDSS

Task Model

Task Knowledge

Recommend Therapy	Condition I	*client. patient. age* < 17
	Action I	*client. recommendation. medication* = 'cefuroxime'
	Condition II	*client. patient. age* > *17*
	Action II	*client. recommendation. medication* = 'amoxicillin'
	Condition III	'penicillin' ε *client. patient. activeMedication*
	Action III	*client. recommendation. medication* = 'levofloxacin'

Task Data

Client-side: patient, visit

Figure 9: Recommend Therapy task service where diagnosis equals to "acute sinusitis".

based on the client-side patient and visit databases.

4. *Incremental Decision Model Builder* (task service): receives a diagnosis report and returns a task to rebuild,complete, and apply an incremental decision model based on the client-side patient and visit databases (incremental models can be adjusted and modified based on the new training data).

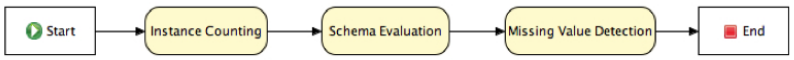
5. *Recommend Dose* (task service): receives a medication and returns the corresponding dose guidelines.

6. *Drug Interaction* (data service): receives a target medication and the list of active medications and returns warnings if there is one or more drug to drug interaction.

6.3 Service Representative

The service representative performs the composite task as follows. The physician diagnoses a disease(i.e., "acute sinusitis" in this example) in a patient. The service representative executes the task received from *recommend therapy* to calculate gMedication (Figure 9). Then, it verifies local databases using *database checker* task service (Figure 10). If patient database and visit database have enough records, service representative executes the task received from *decision model builder* to build a decision model completely from local data (Figure 13). Otherwise, the service representative receives an incomplete model from *incremental decision model builder* and completes it based on local databases (Figure 14). Service representative applies the decision model on patient health record to obtain mMedication. The internal knowledge base of the service representative contains the required functions to build and apply decision trees (both incremental and non-incremental). Next, service representative executes the task received from *recommend dose* for gMedication and mMedication to calculate gDose and mDose (Figure 12). Finally, *drug interaction* data service is called for (gMedicine, activeMedication) as well as (mMedicine, activeMedication) to generate

Task Model



Task Knowledge

Instance Counting	Action	SET *client.localdbInfo.patientInstances* = SELECT COUNT (*) FROM *patientdb*
	Action	SET *client.localdbInfo.visitInstances* = SELECT COUNT (*) FROM *visitdb*
Schema Evaluation	Condition	NOT EXISTS (SELECT * FROM INFORMATION_SCHEMA.COLUMNS WHERE TABLE_NAME = 'visitdb' AND COLUMN_NAME = 'diagnosis')
	Action	*client.localdbInfo.status* = Invalid
Missing Value Detection	Condition	EXISTS (SELECT * FROM visitdb WHERE diagnosis IS NULL OR medication IS NULL)
	Action	*client.localdbInfo.status* = Invalid

Task Data

Client-side: patientdb, visitdb, localdbInfo

Figure 10: Database Checker task service where schema equals to communication channel schema.

the necessary drug interaction warnings. Tasks results are stored in the recommendation port of the communication channel that is shown in Figure 11.

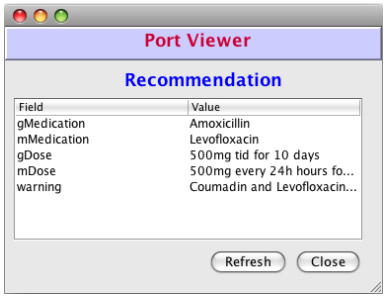


Figure 11: The content of the recommendation port after the service representative completes the composite task.

6.4 Evaluation

Since patient and visit information are kept local, the client privacy is maintained. Moreover, the proposed client-side service composition has a better performance compared to traditional server-side service composition approaches according to the following metrics.

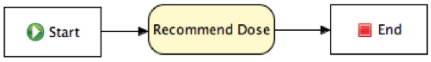
Service Message Size (SMS) is the total size of service request and response messages defined as follows.

$$SMS(s) = Size_{Request}(s) + Size_{Response}(s)$$

Traditional (server-side) service composition approaches require transferring complete client data from client to the server. Although they return small response messages containing final decision, the request message has almost the same length as client data (i.e., patient and visit databases and records in this case study). Moreover, the collaborating web services are either integrated into a central provider or distributed over the network. The latter requires additional sending the client data from the central provider to the partner service providers.

On the other hand, the proposed (client-side) service composition approach processes client data locally that implies SMS is independent of the length of client data. Therefore, the request message is short while the response messages are quite large containing the task definition. Figure 15 illustrates a comparison of these approaches in terms of SMS where they model the presented case study. A logarithmic scale is used to show the lower values more clearly.

Task Model



Task Knowledge

Recommend Dose	Condition I	$15 < client.patient.age < 60$
	Action I	$client.recommendation.dose$ = '500 mg every 24 hours for 14 days'
	Condition II	$15 < client.patient.age < 60$ and $1.4 < client.patient.creatinineLevel < 50$
	Action II	$client.recommendation.dose$ = '250 mg every 24 hours for 14 days'

Task Data

Client-side: patient, visit

Figure 12: Recommend Dose task service where medication equals to "amoxicillin".

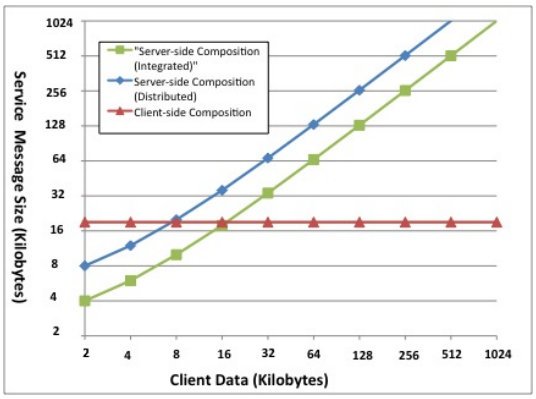


Figure 15: Service Message Size comparison.

Service Response Time (SRT) is divided into two factors: Network time (N) and Process time (P) defined as follows.

$$SRT(s) = N(s) + P(s)$$

Network time is the amount of time required to transfer request and response messages that depends on both network bandwidth and message size. Process time is the amount of time it takes a web service performs its designated task. Since, servers use more powerful CPUs, server-side approaches have less process time. On the other hand, the proposed client-side approach requires smaller messages causes less network time.

For this case study, we obtained the process time ($P(s)$) for different size of client data using a 2.4 GHZ CPU. Moreover, we assume $P_{ServerSide}(s) = \frac{1}{2}P_{ClientSide}(s)$ and a high-speed bandwidth (1 Mbyte/Sec) connects the client to the server. Figure 16 shows the result of comparison between the client-side and an integrated server-side service composition in terms of SRT. This result shows the proposed approach overcomes the traditional approaches when the client data grows.

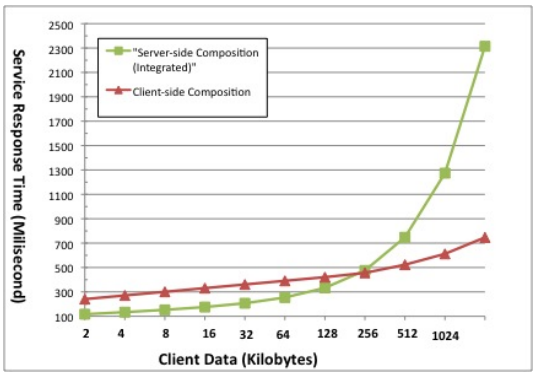


Figure 16: Service Response Time comparison.

Average Response Time (ART) extends the SRT metric when multi clients invoke a service simultaneously. ART for service s where it has n simultaneous clients is defined as follows.

$$ART(s,n) = \frac{1}{n} * \sum_{i=1}^{n} SRT(S_i)$$

To compute ART for the traditional approaches, we consider a non-preemptive queue for the server processor that results as follows:

$$P_{ServerSide}(s,n) = n * P_{ServerSide}(s)$$

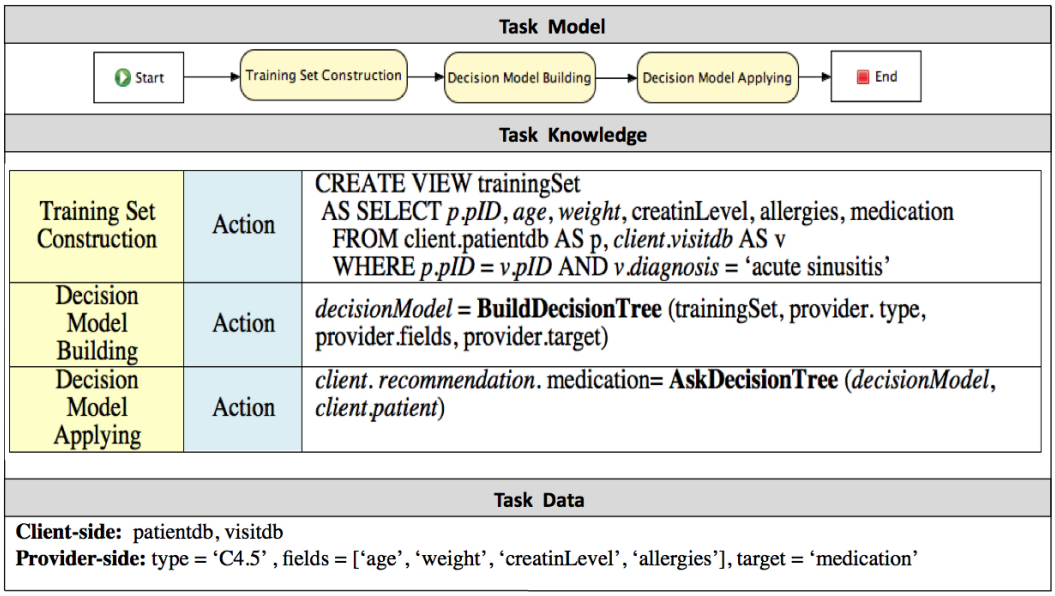


Figure 13: Decision Model Builder task service where diagnosis = acute sinusitis. The external task knowledge are highlighted and C4.5 is the type of decision tree.

where $P(s, i)$ represents the process time of service s when i clients call the service simultaneously. The comparison result is shown in Figure 17. In the proposed approach, service clients have their own service representatives that process client data simultaneously, therefore the ART is improved significantly.

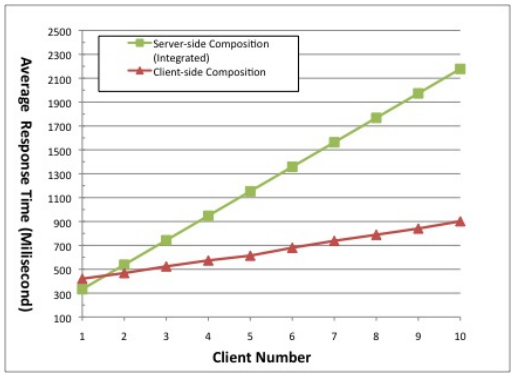


Figure 17: Average Response Time comparison.

7 Related Work

One of the strengths of web services is their capacity to be composed into high-level business processes. Several approaches have been proposed to address service compositions in different ways. Orchestration and choreography describe two aspects of organizing web services in a composite web service [3]. While orchestration requires a central process to coordinate sending and receiving messages among web services, the collaborating web services communicate directly in choreography. Moreover, static composition takes place during design-time while dynamic composition selects collaborating services at the run-time [10]. While all traditional approaches compose web services at the server side, the proposed framework intends to compose services at the client side to improve security, privacy, and efficiency of composite services in some applications.

In context-aware service composition, contextual information is considered for selecting and binding service components in a composite service [4]. These approaches use semantic descriptions of services and contexts to provide adaptive composite services [15]. Therefore, more service metadata and analysis are

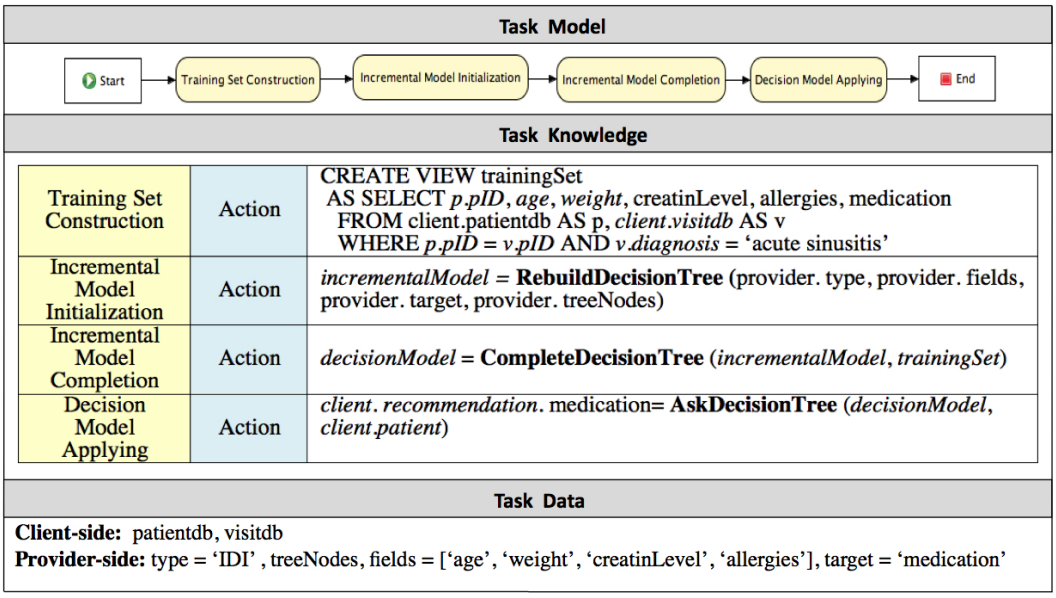


Figure 14: Incremental Decision Model Builder task service where diagnosis = acute sinusitis. The external task knowledge are highlighted and IDI is the type of incremental decision tree.

required. Since, client's context is processed locally in our approach, the service client receives customized services. In other words, we propose context-aware services while service responses are context-free that facilitates service composition.

A software agent is a piece of software that acts on behalf of an agency to serve a user [6]. Software agents have been integrated into web services [12] and used to facilitate SOA related tasks such as service composition [14]. Integration of agents and web services is proposed to model the business aspects of enterprise systems, where each role or major function of an enterprise system is considered as an agent [13]. In this paper, we assign a new role (i.e., service representative) to software agents to model enterprise agents in business domain.

Mobile agents [2] can physically travel across a network and perform tasks on different nodes. There are several security and privacy issues to be considered in mobile agent computing. Mobile agent architectures (e.g., Concordia [11] and Mole [1]) also suffer from low efficiency as they need to send the entire computer program or process. In contrast, we propose to employ generic resident agents and customize them using service messages as opposed to send mobile agents to the client.

Finally, [9] introduces a framework for data and knowledge interoperability where it enables knowledge (i.e., medical guideline) to be transferred in association with data (i.e., patient EMR). In [5], we propose a framework for context-aware services where a resident generic agent at the client side has access to client's context and provides customized services by applying customization knowledge on the general service responses (both received from the service provider). In this paper, we extend these works by introducing task services as well as the generic service representative to perform them at the client side.

8 Conclusions

This paper proposes a new computational model for SOA client-server computing when service provider processes the server part and defines a task for the generic service representative to perform the client part. Next, we equipped the service representative with a service orchestrator to call different task services in a defined order to address an approach

for the client-side service composition. Consequently, the client is not asked to transfer its confidential or large data and resources to the service provider and hence the security, privacy, and efficiency features of enterprise systems will be improved. We plan to extend the SOA reference model with other generic components such as collaboration supervisor to support client-side service composition. Finally, the proposed approach requires short messages to process client resources that matches well with mobile devices requirements, therefore we are working to develop a light version of the service representative to be installed on mobile devices and perform task services.

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